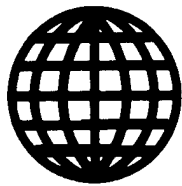


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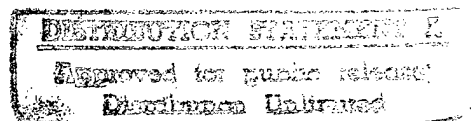
# ***JPRS Report***

## **Science & Technology**

***Central Eurasia:  
Electronics & Electrical Engineering***

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# Science & Technology

## Central Eurasia: Electronics & Electrical Engineering

JPRS-UEE-93-005

### CONTENTS

16 July 1993

#### Acoustics, Signal Processing

Sensitivity Comparison of Different Types of Acoustic Thermometers [A. A. Anosov, V. I. Pasechnik; <i>AKUSTICHESKIY ZHURNAL</i> , Vol 39, No 2, Mar-Apr 93]	1
Digital Remotely Controlled Radio System for Underwater Detection and Processing of Acoustic Signals and Its Application for Studying the Characteristics of Sea Reverberation [L. F. Bondar, A. V. Gritsenko, et al.; <i>AKUSTICHESKIY ZHURNAL</i> , Vol 39, No 2, Mar-Apr 93]	1
Experimental Study of the Field of a Powerful Parametric Radiator in a Shallow Sea [D. M. Donskoy, V. Yu. Zaytsev, et al.; <i>AKUSTICHESKIY ZHURNAL</i> , Vol 39, No 2, Mar-Apr 93]	1
The Effect of Nonlinear Reflection of Diverging Acoustic Rarefaction Waves in the Atmosphere [Yu. V. Petukhov; <i>AKUSTICHESKIY ZHURNAL</i> , Vol 39, No 2, Mar-Apr 93]	1

#### Broadcasting, Consumer Electronics

The CP/M-80 for "Orion-128" [G. Rogov, M. Bridzhidi; <i>RADIO</i> , No 5, May 93]	2
Modification of a Noise Suppressor [S. Kuznetsov; <i>RADIO</i> , No 5, May 93]	2
Underwater Flash Lights [Yu. G. Basov, Ye. S. Gorbalev, et al.; <i>SVETOTEKHNIKA</i> , No 4, Apr 93]	2
New Flash Light Systems [S. I. Bolshakov, L. V. Rodionov, et al.; <i>SVETOTEKHNIKA</i> , No 4, Apr 93]	2
Radiation Model of Cloudless Atmosphere Covering Optical Region of Spectrum [L.N. Orlova; <i>SVETOTEKHNIKA</i> , No 2, Feb 93]	2
Optical Schemes for Glide Path Lights [Ye.Yu. Bibayev, P.P. Grushin, et al.; <i>SVETOTEKHNIKA</i> , No 2, Feb 92]	3

#### Antennas, Propagation

Phasing of Millimeter Antenna Arrays With Optical and Electron Beam Control (Overview) [A. Yu. Grinev, A. Ye. Zaykin; <i>IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA</i> Vol 36 No 5-6, May-Jun 93]	4
Current State and Prospects for the Development of Dipole Antennas With Reactive Assemblies (Overview) [V. G. Sayko, A. V. Artemyev, et al.; <i>IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA</i> Vol 36 No 5-6, May-Jun 93]	4
Study of a Waveguide Phased Antenna Array With Mathematical Modeling for Electromagnetic Compatibility [Ye. M. Andreyevskaya, K. G. Klimachev; <i>IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA</i> Vol 36 No 5-6, May-Jun 93]	4
Multimode Waveguide Matching Structures in Phased Antenna Arrays [V. M. Maksimov, I. G. Sukharev; <i>IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA</i> Vol 36 No 5-6, May-Jun 93]	4
Transformation of Fields and Their Correlation Functions into the Spectral Characteristics of Extended Sources of Wideband Radiation [V. K. Volosyuk; <i>IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA</i> Vol 36 No 5-6, May-Jun 93]	4
Aurorae Borealis and Magnetic Storms [A. N. Krylov; <i>USPEKHI FIZICHESKIKH NAUK</i> , Vol 163, No 4, Apr 93]	5
The Latest on Light Scattering [G. S. Landsberg; <i>USPEKHI FIZICHESKIKH NAUK</i> , Vol 163, No 4, Apr 93]	5

#### Circuits, Systems

Analysis of the Effect of the Parameters of the Sum-Difference Converter of a One-Pulse Direction Finder on the Accuracy of Target Angular Coordinate Measurement [S. M. Latinskiy; <i>RADIOTEKHNIKA</i> No 10, Oct 92]	6
--	---

The Threshold Problem in a Signal Receiver With One-Band Frequency Modulation [M. M. Shakhmayev; <i>RADIOTEKHNIKA</i> No 10, Oct 92]	6
Comprehensive Information Processing in Two-Coordinate Radio Direction Finders [A. V. Ochnev; <i>RADIOTEKHNIKA</i> No 10, Oct 92]	6
Analysis of the Characteristics of High-Resolution Direction Finding Algorithms [M. V. Ratynskiy; <i>RADIOTEKHNIKA</i> No 10, Oct 92]	6
Acousto-Optic Three Dimensional Filter Based on a Coherent Communication Line [T. V. Babkina, V. V. Grigoryants, et al.; <i>RADIOTEKHNIKA</i> No 10, Oct 92]	6

## Instrumentation, Measurements

Universal Computer Complex for Testing and Control of On-Board Electrical Automatic Systems [A. A. Minenkov, V. F. Korolev, et al.; <i>IZMERITELNAYA TEKHNIKA</i> , No 4, Apr 93]	8
The Interpolator for Precision Meters of Time [V. A. Bepalko; <i>IZMERITELNAYA TEKHNIKA</i> , No 4, Apr 93]	8
A Method for Forming a Net of Precision AM Signals, Based on Binary Amplitude Modulation of Rectangular Pulses [M. Ya. Mints V. N. Chinkov; <i>IZMERITELNAYA TEKHNIKA</i> , No 4, Apr 93]	8
A Test Delta-Pulse for Measuring the Dispersed Delay Line's Parameters of Fourier Processors [Yu. V. Koltsov, A. V. Chernogubov; <i>IZMERITELNAYA TEKHNIKA</i> , No 4, Apr 93]	8

## Industrial Electronics, Control Instrumentation

The Superconductivity in Doped $A_xC_{60}$ Fulleride [V. M. Loktev, E. A. Pashitskiy; <i>ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI</i> , Vol 103, No 2, Feb 93]	9
Heat Capacity of Copper-Free Oxide Superconductor $Ba_{0.6}K_{0.4}BiO_3$ in Magnetic Fields [G. Kh. Panova, A. A. Shikov, et al.; <i>ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI</i> , Vol 103, No 2, Feb 93]	9
Electron Inelastic Light Scattering in a Superconductor and in a Normal Metal With Impurities [L. A. Falkovskiy; <i>ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI</i> , Vol 103, No 2, Feb 93]	9
Experimental Study of Film Condensation in Horizontal Enhanced Tubes [S. I. Tsaturyan, S. S. Markelov; <i>SIBIRSKIY FIZIKO TEKHNIЧЕСКИЙ ZHURNAL</i> , No 1, Jan 93]	9

## Electron Devices

Contact Resistance in Contact Nodes of Capacitors [V. P. Berzan, V. K. Rimskiy, et al.; <i>FIZIKA I TEKHNIKA</i> Jan 93]	10
Compressed (Correlated) Coherent States of Electron Moving in Field of Plane Electromagnetic Wave [I. N. Ovcharov, N. I. Fedosov; <i>IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA</i> , Vol 36 No 2, Feb 93]	10

## Computers

Two-Dimensional Transforms for Signal Microprocessor [P. A. Arutyunov; <i>MIKROELEKTRONIKA</i> May-Jun 93]	11
New Signal Processing Technology for High-Speed Integrated Microwave Circuits [V. I. Gvozdev, G. A. Kuzayev; <i>MIKROELEKTRONIKA</i> May-Jun 93]	11
Study of Photoelectric Characteristics of Two-Channel Overlaid CCD [V. I. Khaynovskiy; <i>MIKROELEKTRONIKA</i> May-Jun 93]	11

## Communications

Strategic Aspects of the Development of Electronic Communications in the Russian Federation [V. B. Bulgak; <i>ELEKTROSVYAZ</i> No 1, Jan 93]	12
Systems of Radio Communication With Manned Spacecraft: History. Means of Improvement [V. I. Meshcheryakov; <i>ELEKTROSVYAZ</i> No 1, Jan 93]	12
Satellite Communication Retransmitters: Retrospective, Problems, Means of Development [A. V. Kasatkin, A. G. Orlov; <i>ELEKTROSVYAZ</i> No 1, Jan 93]	12
Current State and Prospects for the Development of Power Amplifiers for Satellite Communication Transmission Equipment [A. V. Tabakov, Ye. L. Bogatov, et al.; <i>ELEKTROSVYAZ</i> No 1, Jan 93]	12

Features of Multi-Beam Satellite Communication Systems With Signal Switching [M. I. Romanovskiy; ELEKTROSVYAZ No 1, Jan 93]	13
Connection Problems in Satellite Communications Systems Based on Low-Orbit Spacecraft [V. V. Sokolov, V. A. Pylysov; ELEKTROSVYAZ No 1, Jan 93]	13
Multiple Use of Frequencies in Low-Orbit Satellite Communication Systems [V. I. Meshcheryakov, V. V. Sokolov, et al.; ELEKTROSVYAZ No 1, Jan 93]	13
Problems in the Development of a Specialized Inertial Navigation System for Mobile Satellite Radio Communication Stations [V. S. Vorobyev, O. P. Dyakov, et al.; ELEKTROSVYAZ No 1, Jan 93]	13
Development of Analog Microelectronic Devices for Satellite Communication Equipment [Yu. Z. Annenkov, D. P. Yevdokimov; ELEKTROSVYAZ No 1, Jan 93]	14
New Generation of Acousto-Electronic Frequency Selection Devices for Communication Systems [Yu. Z. Annenkov, P. G. Ivanov, et al.; ELEKTROSVYAZ No 1, Jan 93]	14

## Power Engineering

Interconnections of Russian and Other Countries' Power Systems [V.V. Yershevich, V.Yu. Kurochkin; ELEKTRICHESTVO, No 5, May 93]	15
Electromagnetic Fields of Pulsating Currents [Ye.S. Kolechitskiy, V.N. Moiseyev, et al.; ELEKTRICHESTVO, No 5, May 93]	15
Determining Volume Density of Electromagnetic Forces in Nonlinear System by Energy Method [Yu.V. Abramkin; ELEKTRICHESTVO, No 3, Mar 93]	15
Strategies for Reducing Losses and Improving Quality of Electric Energy in Power Networks: Discussion [L.M. Zeltsburg; ELEKTRICHESTVO, No 3, Mar 93]	16
Model of Regulating Transformer With Shunted Moving Coil of High-Temperature Superconductor Ceramic [V.V. Aleksandrov, V.N. Yelagin, et al.; ELEKTROTEKHNIKA, No 3, Apr 93]	16

## Magnetics

New Surface Structures and Spin-Flipping Phase Transitions in Anisotropic Magnetic Superlattices [A.K. Zvezdin, S.N. Utochkin; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, Vol 57 Nos 7, 10 Apr 93]	18
Addition of Alternating Magnetic Field to Constant Magnetic Field in Type-II Superconductor [V. Bryksin, S.N. Dorogovtsev; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, Vol 57 No 7, 10 Apr 93]	18
Collective Vibrations in a Three-Band Superconductor [V. A. Palistrant; TEORETICHESKAYA I MATEMATICHESKAYA FIZIKA, Vol 95 No 1, Apr 93]	18
Screening Properties of Nonhomogeneous Superconducting YBaCuO Films in a Magnetic Field [S. A. Vitkalov; ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, Vol 103 No 4, Apr 93]	19
Dipole Radiation of Surface Electromagnetic Waves in Superlattices [S. V. Shiyonovskiy, S. A. Yatskevich; ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, Vol 103 No 4, Apr 93]	19

## Industrial Applications

Effect of Armature Reaction in Linear Permanent-Magnet Motors With Controllable Current Layer [A.A. Afonin, P.N. Belyy, et al.; TEKHNIЧЕСКАЯ ELEKTRODINAMIKA, No 1, Jan-Feb 93]	20
Basic Technological Aspects of Organizing Small-Scale Production of 300-600 W Electric Household Motors Under Present Manufacturing Conditions [V.S. Sysoyev; TEKHNIЧЕСКАЯ ELEKTRODINAMIKA, No 1, Jan-Feb 93]	20
Personal Computers Used To Code Parts [E. A. Pil; PRIBORY I SISTEMY UPRAVLENIYA, No 3, Mar 93]	20
Methods and Devices To Monitor the Topological Characteristics of a Set of Objects in Industrial Vision Systems [A. L. Drzhevetskiy, V. N. Kontishev; PRIBORY I SISTEMY UPRAVLENIYA, No 3, Mar 93]	21
Automated System To Monitor the Mounting of Printed Circuit Boards AMTs 14320 [A. A. Milova, M. F. Nenarokov, et al.; PRIBORY I SISTEMY UPRAVLENIYA, No 3, Mar 93]	21
Experience in Using Glues in Instrument Building [A. M. Galchutkin; PRIBORY I SISTEMY UPRAVLENIYA, No 3, Mar 93]	21

Technique of Experiments for Investigation of Single Failure Events in Digital Integrated Circuits [Ye.R. Astvatsaturyan, A.A. Belyanov, et al.; PRIBORY I TEKHNIKA EKSPERIMENTA, No 1, Jan-Feb 93] .....	21
Frequency Synthesizer for Ultrahigh-Frequency Automatic Control Systems [A.V. Nikonov, G.V. Nikonova; PRIBORY I TEKHNIKA EKSPERIMENTA, No 1, Jan-Feb 93] .....	22

### Quantum Electronics, Electro-Optics

Nonlinear Self-Consistent Theory of Free Electron Lasers [V. V. Kulish, S. A. Kuleshov; UKRAINSKIY FIZICHESKIY ZHURNAL, Vol 38 No 2, Feb 93] .....	23
Effect of Critical Fluctuations on Phase Transition in a Superconductor With Mixed Pairing [A. E. Filippov, A. V. Radiyevskiy; UKRAINSKIY FIZICHESKIY ZHURNAL, Vol 38 No 2, Feb 93] ....	23
Telescopic System for Generating Laser Beams With Phase Conjugation Compensation for the Output Path [M. V. Vasilyev, V. Yu. Venediktov et al.; KVANTOVAYA ELEKTRONIKA, Vol 20 No 4, Apr 93] .....	23
Highly Stable Single-Frequency Solid-State Lasers [N. V. Kravtsov and O. Ye. Naniy; KVANTOVAYA ELEKTRONIKA, Vol 20 No 4, Apr 93] .....	23
High Orders of Continuum Approximation in the Description of Supersonic Large-Amplitude Acoustic Solitons [S. A. Beklemishev, V. L. Klochikhin; FIZIKA TVERDOGO TELA, Vol 34 No 11, Nov 92] ..	23
Electron Localization and Optical Properties of Superlattices in an Electric Field [A. G. Zhilich; FIZIKA TVERDOGO TELA, Vol 34 No 11, Nov 92] .....	24
Laser Annealing of High-Temperature Superconductors [Ya. O. Dovgiy, I. V. Kityk, et al.; FIZIKA TVERDOGO TELA, Vol 34 No 11, Nov 92] .....	24
Methodes and Equipment for Spectral and Kinetic Studies of a High Time Resolution. (Review) [Ye. S. Voropay, V. V. Danilevich, et al.; ZHURNAL PRIKLADNOY SPEKTROSKOPII, Vol 58, No 1-2, Jan-Feb 93] .....	24
The Effect of Pumping Radiation Polarization on the Generation Characteristics of Dye Lasers L. I. Burov, A. V. Zhvalevskiy, et al.; ZHURNAL PRIKLADNOY SPEKTROSKOPII, Vol 58, No 1-2, Jan-Feb 93] .....	25
Amplitude Focusing in Open Optical Cavities A. P. Khapalyuk; ZHURNAL PRIKLADNOY SPEKTROSKOPII, Vol 58, No 1-2, Jan-Feb 93] .....	25
Limitations in Implementing Multistage Laser Amplifiers [V. V. Lobachev, V. L. Moshkov; INZHENERNO-FIZICHESKIY ZHURNAL, Vol 64 No 1, Jan 93] ....	25
Measuring Brightness Temperature by Wideband Pyrometer [V. N. Snopko; INZHENERNO-FIZICHESKIY ZHURNAL, Vol 64 No 1, Jan 93] .....	26
Recording of the Wave Front Reversal-Holograms at the Junctions in an Excited Channel of Rhodamine 6-Zh Dye [Dzhikhad Addasi, A. L. Tolstik, et al.; VESTNIK BELORUSSKOGO GOSUDARSTVENNOGO UNIVERSITETA: FIZIKA, MATEMATIKA, MEKHANIKA, No 1, Jan 93] .....	26

### Solid State Circuits

Resonant Excitation of Vibrational Modes in the Microrelief Surface of GaAs [N. L. Dmitruk, N. V. Kotova, et al.; FIZIKA TVERDOGO TELA, Vol 35 No 1, Jan 93] .....	27
Experimental Field Effect Transistor Based on Polytype 4H Silicon Carbide [M. M. Anikin, P. A. Ivanov, et al.; FIZIKA I TEKHNIKA POLUPROVODNIKOV, Vol 27 No 1, Jan 93] .....	27
Deep Traps in n-GaAs Bombarded by Fast Neutrons [V.N. Brudnyy, N.G. Kolin, et al.; FIZIKA I TEKHNIKA POLUPROVODNIKOV, Feb 93] .....	27

**Sensitivity Comparison of Different Types of Acoustic Thermometers**

937K0177A Moscow AKUSTICHESKIY ZHURNAL  
in Russian Vol 39, No 2, Mar-Apr 93 pp 207-212

[Article by A. A. Anosov, V. I. Pasechnik, Scientific and Engineering Center of Biomedical Radioelectronics at RAS Institute of Radioengineering and Electronics; UDC 534.8]

[Abstract] Values of the basic parameters of an acoustic thermometer (AT) are obtained. This includes the noise temperature, equivalent bandwidth and the threshold sensitivity of piezotransducers without matching layers as well as with a quarterwave matching layer. Taking into account the actual values of the AT parameters: losses in the piezotransducer without a quarterwave matching layer, the high frequency amplifier noises, and employing a modulator and a quadrature detector, the design value of the threshold sensitivity is about 0.4 K. This is significantly greater than the threshold sensitivity value obtained without accounting for these parameters. For piezotransducers with a quarterwave matching layer, the threshold sensitivity value can be reduced down to 0.1 K. It was demonstrated that due to a better matching with the ambient media and a wider bandwidth, the piezotransducers with the matching layers have a better threshold sensitivity. The high frequency amplifier noise can be reduced by using a properly selected transformer. Figures 3, references 6: 4 Russian, 2 Western.

**Digital Remotely Controlled Radio System for Underwater Detection and Processing of Acoustic Signals and Its Application for Studying the Characteristics of Sea Reverberation**

937K0177B Moscow AKUSTICHESKIY ZHURNAL  
in Russian Vol 39, No 2, Mar-Apr 93 pp 223-229

[Article by L. F. Bondar, A. V. Gritsenko, V. A. Zakharov, D. V. Kovzel, A. N. Rutenko, Pacific Ocean Oceanologic Institute, RAS Far Eastern Military District; UDC 534.232]

[Abstract] The design concepts and functioning of a digital multichannel system for collecting and processing analog signals is described. This system is employed with the self-contained radio underwater acoustic sensing system "Otklik-91". It consists of a set of functionally related programmable modules, adapted to the nature of the problems which are to be solved. On-board devices provide for display of all measured parameters, computer data input, preliminary processing and storing of data. Potential capacity of the digital underwater acoustic signal sensing system "Otklik" and the associated software is illustrated by an example of the analysis of vector-phase characteristics of the reverberation signal obtained with the combination acoustic sensor in an in-situ experiment conducted near a shelf with a complex relief of the bottom and the shore line. Figures 2, references 4 Russian.

**Experimental Study of the Field of a Powerful Parametric Radiator in a Shallow Sea**

937K0177C Moscow AKUSTICHESKIY ZHURNAL  
in Russian Vol 39, No 2, Mar-Apr 93 pp 266-274

[Article by D. M. Donskoy, V. Yu. Zaytsev, K. A. Naugolnykh, A. M. Sutin, RAS Institute of Applied Physics, RAS Institute of Acoustics; UDC 534.2]

[Abstract] This work deals with in-situ measurements of the field and the pulsed signal structure generated by a powerful parametric acoustic radiator in a shallow sea, and a theoretical interpretation of the results. The feasibility of employing such a radiator for studying the acoustic propagation in the ocean is also discussed. A powerful radiator located aboard a ship with a  $2 \times 6 \text{ m}^2$  aperture was used for the experiments. The radiator was positioned under the ship's keel at a depth of 5 m. In the parametric mode of operation, different frequency pumping signals in the 2.9-3.9 KHz range were applied to the right and the left halves of the radiator aperture, so that the difference frequency could be varied within 200-1,000 Hz. The acoustic radiation power of the pumping waves was about 24 KW. The signals were received by a hydrophone located at a depth of 100 m. For comparison, a regular monopole radiator was used in addition to the parametric radiator. It was demonstrated that the parametric radiator excites a significantly more limited group of modes than the regular monopole radiator. The feasibility of a selective excitation of a specified group of modes and formation of a narrow pattern in a horizontal plane, which can not be produced by any other known methods was also demonstrated. Figures 8, references 17: 16 Russian, 1 Western.

**The Effect of Nonlinear Reflection of Diverging Acoustic Rarefaction Waves in the Atmosphere**

937K0177D Moscow AKUSTICHESKIY ZHURNAL  
in Russian Vol 39, No 2, Mar-Apr 93 pp 326-332

[Article by Yu. V. Petukhov, RAS Institute of Applied Physics; UDC 534.2:551.596.1]

[Abstract] Theoretical foundations are developed for the effect of nonlinear reflection in diverging rarefaction waves propagating in the Earth atmosphere. Only the vertical propagation of an arbitrary shape rarefaction wave is examined. It is demonstrated that in isothermal exponential atmosphere the propagation velocity of the diverging rarefaction wave goes to zero at a certain critical altitude, which decreases with increased initial amplitude of pressure. At this altitude the Mach number reaches its maximum possible negative value, which depends only on the index of air isoentropy. At altitudes greater than critical, continued increasing of the Mach number in its modulus is limited by manifestation of the effect of total nonlinear reflection. This effect is characterized by the sign reversal of the corresponding section of the rarefaction wave profile propagation velocity. Figures 2, references 19: 13 Russian, 6 Western.

**The CP/M-80 for "Orion-128"***937K0211A Moscow RADIO in Russian No 5, May 93  
pp 18-19*

[Article by G. Rogov, M. Bridzhidi]

[Abstract] A disk drive controller for the "Orion-128" computer is described. The controller uses a special KR1818VG93 LSIC. It consists of a single chip programmable device, designed for controlling the disk drives, the information exchange process and the correction devices when recording a data on the disk. The micro-circuit provides for automatic control of the readout information, for changing the sector size and the track searching mode, making it possible to program the controller in the recording format. Devices which expand the functional capacities of the LSIC and which serve for linking the floppy disk with a computer, for signal conversion and the disk drive and disk-side selection are also incorporated in the controller. An electrical block diagram of the controller is provided, and the circuit elements are listed. The controller is a modified model of the earlier models and carries a designation V3.30. Figures 2, table 1.

**Modification of a Noise Suppressor***937K0211B Moscow RADIO in Russian No 5, May 93  
p 32*

[Article by S. Kuznetsov]

[Abstract] A noise suppressor with adaptive recovery time had been developed and described in the "Radio", No 11, 1988. The noise suppressor exhibits good dynamic characteristics and a high level of noise suppression, however, its application is limited by the requirements to the signal source (output voltage 100...200 mV, output impedance several kOhms). The output voltage of most signal sources is 250... 500 mV, and the output impedance of some of them is several tens of kOhms. Modifications, which would make this noise suppressor more universal were developed and a modified circuit is provided in this article. The output stage consists of a non-inverting follower, with high input and low output impedances. The divider attenuate the input signal to the required level and determines the input impedance of the device (220 kOhm). The disconnecting circuit of the noise suppressor was also changed. Adjustment of the modified section of the device is very simple. Figures 1, references 2 Russian.

**Underwater Flash Lights***937K0200A Moscow SVETOTEKHNIKA IN Russian  
No 4, Apr 93 pp 11-13*

[Article by Yu. G. Basov, Ye. S. Gorbaletov, Yu. A. Gromov, V. S. Prokudin, Moscow Energy Institute, Special Design and Technological Bureau for Light and Light-Signalling Devices Scientific-Production Association "Elektroluch"; UDC 628.94:621.32.017.7]

[Abstract] Several types of contemporary underwater flash lights (UFL) manufactured by the domestic industry are described and their characteristic is listed in a table. The flash lights are employed for underwater light signalling and for photography. Flash light "Raduga-I" which contains two cylindrical mirror reflectors is a most advanced design. Devices with two reflectors have a greater capacity for producing a specified light distribution. The range of the UFL depends on the water transparency. Because the water in rivers, lakes and seas is muddy, the range of the here described flash lights is not greater than 3-8 m. The fundamental requirement to the system of flash lighting of underwater objects lies in the necessity of producing a specified illumination of the object's optical image on the photo-film. When designing each model of flash light, the underwater target's illumination requirements were taken into the account, and the field tests demonstrated that both black and white and color photographs were of high quality. Figures 4, table 1, references 2 Russian.

**New Flash Light Systems***937K0200B Moscow SVETOTEKHNIKA IN Russian  
No 4, Apr 93 p 14*

[Article by S. I. Bolshakov, L. V. Rodionov, G. N. Senilov, A. G. Simakin, Moscow Institute of Energetics, Ordzhonikidze Lamp Factory; UDC 621.327.52]

[Abstract] Red flash lights of the type SMI-2KM, developed in the Moscow Institute of Energetics (MEI) have a frequency of 1 Hz which is optimal for pilot's attention. However, in many situation a frequency of 10 Hz or greater, a shorter pulse time, as well as use of coded signals is required. Engineering parameters of various pulsed devices developed by the MEI during the recent years are listed in a table. The most important engineering feature of the lights are described. In addition to the lights which are listed in the table, the following devices have been developed: a model for Navy aviation as a backup for radio communication system with submarines by coded signals; light for radio communication between helicopters or aircraft with armored personnel carriers or tanks (SIO-81); a fully self-contained flash light for Taiga or Far-North regions (SIO-71); a self-contained infrared flash light (SIO-77) and other devices. Table 1, references 2 Russian.

**Radiation Model of Cloudless Atmosphere Covering Optical Region of Spectrum***937K0169A Moscow SVETOTEKHNIKA in Russian  
No 2, Feb 93 (manuscript received 30 Sep 92, signed to  
press 22 Dec 92) pp 1-4*

[Article by L.N. Orlova, candidate of technical sciences, Nizhegorod Institute of Architecture and Structural Engineering; UDC 628.9.021]

[Abstract] A multiparametric optical radiation model of the atmosphere covering the 290-5000 nm range of the

spectrum is proposed which should facilitate a more comprehensive than heretofore evaluation of solar radiation needed for lighting design. The model is based on modern actinometry and Bouguer's. For the 290-760 nm ultraviolet and visible range is used the Lambert's approximation, with the attenuation coefficient characterizing the subozone layer regarded as the sum of two components representing absorption by aerosol and Rayleigh scattering respectively. In the 760-5000 nm infrared range are considered individual transmission and absorption bands of  $H_2$  and  $CO_2$ . The spatial-temporal characteristics of directly incident radiation flux are calculated in accordance with conventional relations of spherical trigonometry. The luminance of radiation in a quasi-plane optical medium is described by the integrodifferential equations of radiation transfer and is calculated according to the approximate theory of multiple scattering, the exact solution to the differential equation of radiation transfer (integral term set to zero) representing the luminance of singly scattered radiation. The scattering indicatrix of a atmosphere is constructed on the based on empirical data. All calculations have been programmed in FORTRAN for computer-aided numerical analysis. The results of calculations made for a cloudless atmosphere and including the relative mean-annual distribution of integral sky luminance agree with the results of measurements made at the Main Geophysical Observatory imeni Voyeykov, at the Institute of Atmospheric Physics (Academy of Sciences), at the Institute of Atmospheric Physics (Estonian Academy of Sciences), at the Institute of Astrophysics (Kazakh Academy of Sciences), at the Moscow State University imeni M.V. Lomonosov, and at the State Institute of Optics imeni S.I. Vavilov. Figures 2; references 6.

#### Optical Schemes for Glide Path Lights

937K0169B Moscow SVETOTEKHNKA in Russian  
No 2, Feb 93 (manuscript received 4 Apr 91, signed to  
press 5 Nov 92) pp 12-15

[Article by Ye.Yu. Bibayev, engineer, P.P. Grushin,  
candidate of technical sciences, and V.S. Prokudin,

candidate of physical and mathematical sciences, Special  
Design and Manufacturing Engineering Office for  
Lighting and Light Signaling Devices; UDC  
628.971.8:656.71]

[Abstract] Six glide path lights have been developed at the Special Office in an effort to ensure correct and safe landing of airplanes, each using a KGM pulse-coded metal halide lamp inside an ellipsoidal reflector. The first (1979) OG white-red model for the VASIS landing system consists of a 6.6 V - 200 W KGM-3 lamp with reflector, a red light filter of rectangular shape in a special frame, and a planoconvex lens made of colorless shield glass. The later (1987) OG-3 white-red model for the PAPI landing system has the same lamp set but improved optics. The still later OG-4 yellow-green-ored model consists of a 24 V - 200 W KGM lamp with reflector, a red or green light filter also serving as glass shield, a planoconvex lens, and a scatterer. It is mounted in two identical fixtures with the common diaphragm located in the focal plane of the lens. The tricolor white-green-red OG "Sineva (Blue)" 1985 model for civilian helicopter landing pads consists of a 12 V - 40 W KGM-2 lamp with reflector, a compound light filter (red semicircular disk - green strip), and a planoconvex lens made of shield glass. It is mounted in a single fixture. The tricolor white-green-red OG "Akvarium (Aquarium)" 1990 model for helicopter pads on floating drill rigs has the same lamp but improved optics adequate for a more restricted landing area. The latest (1991) OG "Signal" white-red model for the APAPI landing system consists of a 6.6 V - 200 W KGM-3 lamp with reflector, a compound light filter (red semicircular disk - colorless semicircular disk). The longest visibility range the OG-3 light: 4.5 mm (red beam) by day and 19 m (white beam) at night. The shortest visibility range gas the OG "Sineva" light: 1.3 m (green beam) by day and 8.2 m (green beam) at night. Models OG, OG-3, OG-4, and OG "Signal" are designed for combination geometrical and color coding. Models OG "Sineva" and OG "Akvarium" are designed for color coding, OG "Akvarium" also including an element for geometrical coding. Figures 3; references 7.



### Phasing of Millimeter Antenna Arrays With Optical and Electron Beam Control (Overview)

937K0205A Kiev IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 36 No 5-6, May-Jun 93 (manuscript received 15 Dec 92) pp 3-17

[Article by A. Yu. Grinev, A. Ye. Zaykin, Moscow Aviation Institute; UDC 621.396.677]

[Abstract] This article examines the construction principle of millimeter antenna systems. Attention is focused on phasing of millimeter antenna arrays with optical and electron beam control using a reflective antenna array with a multilayer semiconductor control panel, an optical or electron beam control system, and a high-frequency excitation device. The properties of semiconductor panels are analyzed. Electrodynamic analysis is also performed. Parameters of autocathode, electron beam, and optical control systems are compared. Antenna array elements are selected, and the problem of diffraction of the incident wave on a periodic system of these elements is solved. Scattering characteristics, the construction scheme, and basic specifications of this type of phasing are presented. Figures 7; table 1; references 16: 13 Russian, 3 Western.

### Current State and Prospects for the Development of Dipole Antennas With Reactive Assemblies (Overview)

937K0205B Kiev IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 36 No 5-6, May-Jun 93 (manuscript received 4 Feb 93) pp 17-28

[Article by V. G. Sayko, A. V. Artemyev, V. Ye. Fedyayev, Kiev; UDC 621.396.67.01]

[Abstract] The problems of providing mobile wideband radio transmission, frequency adaptation, and pseudo-random tuning of operating frequencies can be solved with wideband dipole antennas. This article examines the results of theoretical and experimental studies of domestic and foreign developers of dipole antennas with reactive assemblies. The analysis of mathematical approaches to the design of dipole antennas focuses on domestic research, since foreign theoretical research has been discussed in other publications. Each approach is described in detail, and then compared with other methods. Results of a patent search are presented, and important trends indicated. Details are given on a 3-meter 30-75 MHz antenna produced by Marconi Co. Ltd. The materials presented in this overview can be expediently used to design superior dipole antennas. Figures 5; tables 2; references 39: 30 Russian, 9 Western.

### Study of a Waveguide Phased Antenna Array With Mathematical Modeling for Electromagnetic Compatibility

937K0205C Kiev IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 36 No 5-6, May-Jun 93 (manuscript received 15 Dec 92) pp 35-40

[Article by Ye. M. Andreyevskaya, K. G. Klimachev, Moscow Aviation Institute; UDC 621.396.677]

[Abstract] This article develops a mathematical model for the electrodynamic level and a method for determining the characteristics of a single radiator and a phased antenna array outside the working range of frequencies in multimode excitation. The spectra of higher waves at the apertures of the radiators are calculated, as well as the matching characteristics and the beam pattern at harmonics of the fundamental frequency. It is shown that the quality of suppression of higher harmonics in the excitation device has a substantial effect on the indirect radiation of a phased antenna array. Figures 3; table 1; references 2 (Russian).

### Multimode Waveguide Matching Structures in Phased Antenna Arrays

937K0205D Kiev IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 36 No 5-6, May-Jun 93 (manuscript received 15 Dec 92) pp 3-8

[Article by V. M. Maksimov, I. G. Sukharev, Moscow Aviation Institute; UDC 621.396.677]

[Abstract] This article examines the possibility of using waveguide multimode structures to match the radiators of a phased antenna array. Mathematical models of matching structures are constructed and numerically studied. As a result of examination of a decomposition scheme of finite antenna arrays and phased antenna arrays sectioned with conducting skirting, a factor was discovered which affects the matching of radiators and which is independent of the scanning angle. This factor is the propagating mode closest to the critical mode excited in the space of the multimode waveguide formed by the skirting. Manipulation of the height of the skirting allows one to achieve matching. The prospects for the use of multimode matching structures are discussed. Figures 5; table 1; references 6 (Russian).

### Transformation of Fields and Their Correlation Functions into the Spectral Characteristics of Extended Sources of Wideband Radiation

937K0205E Kiev IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 36 No 5-6, May-Jun 93 (manuscript received 25 Aug 92) pp 27-30

[Article by V. K. Volosyuk, Kharkov Aviation Institute; UDC 537.874.4]

[Abstract] This article proposes a pair of transformations which make it possible to establish the link between the spectral-angular density of the complex amplitude of a wideband field and the field itself, as well as between the spectral brightness of a source of incoherent radiation and the correlator function of the field or its generalization, the complex mutual coherence function. The transformations are examined in an approximation which corresponds to the determination of the far Fraunhofer zone. The formulas which are obtained for the spectral densities are algorithms for the formation of radio images of extended sources of radiation, not only as functions of spatial coordinates (direction cosine) but also of temporal frequencies. References 7 (Russian).

#### **Aurorae Borealis and Magnetic Storms**

937K0199A Moscow *USPEKHI FIZICHESKIKH NAUK* in Russian Vol 163, No 4, Apr 93 pp 3-14

[Article by A. N. Krylov]

[Abstract] A reprint of the chairman's address delivered in January 1917 at the general meeting of the members of Russian Physical and Chemical Society. It was initially published in the "Uspekhi Fizicheskikh Nauk" in April 1918. This historical review deals with early studies of the Aurorae Borealis phenomenon by a Norwegian Scientist prof. Birkeland and a mathematical theory of Aurora Borealis developed by a Norwegian mathematician Karl Stoermer. Stoermer's studies are primarily concerned with the problem: under what conditions a particle carrying an electric charge, emitted by the Sun, reaches the sphere of the Earth's magnetic field. Stoermer conducted photogrammetric surveying together with magnetic observations. After processing these observations, which were not completed at the time of publication, accurate data would be obtained on the current of electrical particles which causes Aurorae

Borealis and magnetic storms. It appears that in essence the problem was solved by the works of Birkeland and K. Stoermer. Figures 20.

#### **The Latest on Light Scattering**

937K0199B Moscow *USPEKHI FIZICHESKIKH NAUK* in Russian Vol 163, No 4, Apr 93 pp 33-50

[Article by G. S. Landsberg]

[Abstract] This article was initially published in the "Uspekhi Fizicheskikh Nauk" in February 1929. The difference between fluorescence and light scattering is discussed after these phenomena have been defined. From the point of view of combination scattering, which is described here, the difference between the fluorescence and scattering ceases to be sharply defined. Light scattering is possible where the induced oscillations of a system are combined with its natural oscillations. Therefore, contrasting the natural oscillations with the induced makes no sense. The phenomenon of combination scattering may be treated as an additional fluorescence. With the regular fluorescence, natural radiation that excites the molecules is readily observed. The remaining energy ("Stokes' shifting") is not examined directly; one can only make more or less plausible assumptions about its fate. On the other hand, with the combination scattering this energy is the subject of studies. The natural oscillation energy is not examined directly, and only the numerical data support the fact that the induced natural radiation is the infrared radiation. Essentially new is the fact of excitation of intensive infrared oscillations by light whose frequency lies in the ultraviolet spectral region. The observed exchange of energy between the light and material doesn't fit the framework of the classical concepts of resonance. Here, we are dealing with processes which are very near or identical to the phenomena of positive and negative absorption, which were postulated by Einstein. From this point of view, the described phenomenon constitutes on other argument in support of the quantum character of light. Figures 3, tables 4, references 60: 2 Russian, 58 Western.

### Analysis of the Effect of the Parameters of the Sum-Difference Converter of a One-Pulse Direction Finder on the Accuracy of Target Angular Coordinate Measurement

937K0222A Moscow *RADIOTEKHNIKA* in Russian  
No 10, Oct 92 (manuscript received 9 Oct 1991)  
pp 33-38

[Article by S. M. Latinskiy; UDC 621.396.98]

[Abstract] A method is proposed for the analysis of the effect of the parameters of sum-difference converters on the accuracy of angular coordinate measurements in single-pulse direction finders. This article analyzes the operation of single-pulse systems with ring waveguide bridge converters. The azimuth tracking channel is analyzed and the results are extended to two-coordinate tracking. Matrix equations are developed for quadrupoles which represent waveguide segments and load resistances. The optimal load resistances are determined. The effect of a change in transmitter frequency on the RMS error in measuring the angular coordinates of the target is determined. When the frequency is not changed the effect of the converter on measurement is insignificant. With frequency change the measurement error greatly exceeds the potential signal measurement error. If the input resistances of the antenna channels and connecting waveguides of single-pulse radar systems are not all equal, this can lead to instrument error in angle measurement. If the resistances are equal and the transmitter frequency is changed, the error is directly proportional to the relative change in frequency. Figures 4; references 4: 3 Russian, 1 Western.

### The Threshold Problem in a Signal Receiver With One-Band Frequency Modulation

937K0222B Moscow *RADIOTEKHNIKA* in Russian  
No 10, Oct 92 (manuscript received 27 Dec 1991)  
pp 38-40

[Article by M. M. Shakhmayev; UDC 621.376.326]

[Abstract] This article examines the noise resistance of a signal receiver with one-band frequency modulation in the phase plane when the noise level is comparable with the signal level. A two-band frequency modulation system is used for comparison. In the case of one-band frequency modulation it is found that noise causes no parasite amplitude modulation. It is found that a one-band frequency modulation system compares favorably with a two-band system in that its frequency band is a factor of two smaller for identical modulation indices. The receiver in the one-band system exhibits no threshold phenomena. Figures 3; references 4 (Russian).

### Comprehensive Information Processing in Two-Coordinate Radio Direction Finders

937K0222C Moscow *RADIOTEKHNIKA* in Russian  
No 10, Oct 92 (manuscript received 7 Sep 91) pp 41-48

[Article by A. V. Ochnov; UDC 621.396:629.7.05]

[Abstract] Greater and greater demands are being placed on the passive radar systems used for aircraft navigation and control. These systems must use optimal (quasi-optimal) algorithms for comprehensive space-time processing of information and a grid of antennas with narrow beam patterns. An effective method of synthesizing optimal processing algorithms is the Markov theory of device and system matching. The Markov theory and the principle of information distribution are used to synthesize a comprehensive signal processing device in a two-coordinate on-board radio direction finder with a two-dimensional antenna grid. Signal phase shifts in the antenna grid are compensated. The algorithm which is obtained is optimized by minimizing the RMS filtering error. A schematic of the device is offered. It can adapt to external wideband noise, thus obtaining the maximum signal to noise ratio. The accuracy and noise resistance of the device are analyzed. Figures 2; references 6 (Russian).

### Analysis of the Characteristics of High-Resolution Direction Finding Algorithms

937K0222D Moscow *RADIOTEKHNIKA* in Russian  
No 10, Oct 92 (manuscript received 20 Jul 91) pp 63-66

[Article by M. V. Ratynskiy; UDC 621.391]

[Abstract] It is shown that high resolution direction finding algorithms are significantly limited by the finite number of learning samples ( $n \geq 2$ ) and by amplitude-phase errors in the circuitry. The resolution for any  $n$  does not exceed the resolution of standard algorithms. There is no practical reason to use the algorithm presented at  $n > 1$  to increase resolution. Figures 4; references 5: 3 Russian, 2 Western.

### Acousto-Optic Three Dimensional Filter Based on a Coherent Communication Line

937K0222E Moscow *RADIOTEKHNIKA* in Russian  
No 10, Oct 92 (manuscript received 1 Nov 91) pp 83-86

[Article by T. V. Babkina, V. V. Grigoryants, Yu. B. Ilin, A. A. Lobanov; UDC 681.7.068]

[Abstract] The amplitude-frequency and phase-frequency characteristics of a three-dimensional acousto-optic filter are studied. The filter is a system consisting of a He-Ne laser, acousto-optic cell, two-wire optical delay line and a heterodyne photoreceptor. This type of device allows one to vary the amplitude-frequency characteristic and the phase-frequency characteristic independently. This filter is a component of a laser generating heterodyne interferometer which is promising for the development of highly sensitive sensors with frequency recording of the effect of the sensor. The principle of operation of the filter is explained. The relative simplicity of the design and general accessibility of filter components, the ability to tune the central

frequency and passband over a wide range of frequencies, and the ability to independently vary the characteristics make this filter very promising for use in various

opto-electronic systems and devices, including fiber optic transmission and data processing systems. Figures 3; references 5: 1 Russian, 4 Western.

**Universal Computer Complex for Testing and Control of On-Board Electrical Automatic Systems***937K0206A Moscow IZMERITELNAYA TEKHNICA in Russian No 4, Apr 93 p 11*

[Article by A. A. Minenkov, V. F. Korolev, A. D. Gorelov; UDC 681.142.62:623.4.018]

[Abstract] A universal computer complex has been developed by the Scientific Research Institute of Aviation Technology for mass production in the Moscow factory "Energopribor". This complex is designed for automated testing of on-board systems of aviation equipment in the input control shops, assembly shops of aviation plants or at their inspection and test stations. The software of the computer complex (UNVK ELIS) is compatible with microcomputers SM1800 and SM1803 and also with the "Microdot" set (KTS LIUSS2). The complex can be used for testing relay boxes, electrical automation systems, for controlling engineering processes, or for designing information and measurement systems with data transmission to the local networks of participating enterprises. The component units of the complex and its functioning is described.

**The Interpolator for Precision Meters of Time***937K0206B Moscow IZMERITELNAYA TEKHNICA in Russian No 4, Apr 93 pp 20-23*

[Article by V. A. Bepalko; UDC 681.335.87:681.11]

[Abstract] Technical characteristics of some foreign made interpolators for accurate time measurements are described. This includes Hewlett-Packard and Stanford Research Systems (SRS) models. The principal shortcoming of the early interpolator models lies in a large transformation time, which is directly proportional to the transformation ratio of the time scale. The latest HP 5371A model and the SRS model SR 620 use different approaches to avoid the increase in the transformation time. An interpolator model with a time scale transformation is examined here and its electrical block diagram is provided. A circuit for separate control of beginning and ending of the capacitor charging assures a minimal mutual effect of the input signal and the clock generator signal. The control process exhibits a high speed, since it is reduced only to switching the currents. Because of separate control of the charge, the voltage on the capacitor is fixed and can be measured by various methods: using a high speed analog-to-digital converter as well as by the method of capacitor discharge with low currents. The fundamental parameters of the interpolator are: period of the clock generator - 25 ns; transformation ratio - 1,000; interval of time sampling - 25 ps; transformation time - 30  $\mu$ s; standard deviation - 35 ps. The nonlinearity characteristic is also described. Figures 3, references 11: 4 Russian, 7 Western.

**A Method for Forming a Net of Precision AM Signals, Based on Binary Amplitude Modulation of Rectangular Pulses***937K0206C Moscow IZMERITELNAYA TEKHNICA in Russian No 4, Apr 93 pp 60-63*

[Article by M. Ya. Mints V. N. Chinkov; UDC 681.317.341(088.8)]

[Abstract] This article deals with methods for forming precise amplitude-modulated (AM) signals that can be produced in calibrators of AM-signals employing digital technology, making it possible to significantly reduce their instrumental error compared to the analog generators of AM-signals. A method is examined here which is based on separation, using narrow band filters, of a net of AM-signals from a pulse-amplitude modulated (PAM) signal with a binary amplitude modulation of a periodic train of rectangular pulses. A calibrator is proposed whose greatest advantages are exhibited in the low frequency region where the capacities of analog calibrators, or any other signal generators are very limited. An analysis is made of the PAM signal and a block diagram of the calibrator is provided. Engineering and economic advantages of the AM-calibrator, based on the proposed method of binary modulation are described. This includes an increased accuracy due to reduced instrumental errors, an expanded upper frequency limit, a shorter measurement time, and simplification of the process of forming the AM-signal. Experimental studies were performed of the calibrator's laboratory sample using two different methods. The results were in good agreement with the design values and lie within the range of instrumental error. Figures 2, references 2 Russian.

**A Test Delta-Pulse for Measuring the Dispersed Delay Line's Parameters of Fourier Processors***937K0206D Moscow IZMERITELNAYA TEKHNICA in Russian No 4, Apr 93 pp 63-65*

[Article by Yu. V. Koltsov, A. V. Chernogubov; UDC 621.317.757.3]

[Abstract] Many problems of signal detection, identification and processing can be solved using Fourier processors on dispersed delay lines (DDL). The accuracy characteristics of the dispersed Fourier processors are mainly determined by the DDL. Normally, the DDL on surface acoustic waves (SAW), are employed on frequencies in the 10 MHz to 2 GHz range. The parameters of the DDL on SAW can be accurately determined with test delta-pulses (TDP). The requirements to the TDP parameters are impossible to satisfy with the available mass produced elements, since a TDP with an amplitude on the order of 100 V and a 100 ps pulse width would be required for measurements of wide-band DDL parameters. In order to reduce the requirements to the TDP former, a TDP can be use with a spectrum which deviates from the ideal spectrum. A wide-band dispersed delay line (DDL) with a 300-600 MHz pass-band is examined here and the minimal value of the testing delta-pulse (TDP) is estimated. A former whose functional block diagram is provided satisfies the required parameters of the TDP. The composite units of the former and their functioning are described. Figures 3, references 11: 8 Russian, 3 Western.

**The Superconductivity in Doped  $A_xC_{60}$  Fulleride**  
937K0191A Moscow ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 103, No 2, Feb 93 pp 594-604

[Article by V. M. Loktev, E. A. Pashitskiy, Ukrainian Academy of Sciences Institute of Theoretical Physics]

[Abstract] It is demonstrated that a high symmetry of the  $C_{60}$  molecules as well as the symmetry of the cubic crystal with face centered lattice, which is formed by those molecules, is responsible for "high temperature" superconductivity of solid fullerene  $C_{60}$ (fulleride), doped by alkali atoms and thallium. Because of the high symmetry of the molecules, a dynamic Jahn-Teller effect is produced when electrons interact with intermolecular oscillations of the fullerene; the symmetry of the cubic crystal causes a multi-valley structure of the conduction band and multiple linkage of the Fermi surface at stoichiometric state of doped fulleride  $A_3C_{60}$  ( $A=K, Rb$  and  $Cs$ ). In contrast to solid hyperfullerides  $C_n$ , for  $n > 70$  with a smaller symmetry of molecules and crystal lattice, both factors contribute to the increase of the electron-phonon coupling constants, and consequently to the increase of critical temperature  $T_c$  of superconducting junction in the  $A_3C_{60}$  ( $RbTi_2C_{60}$ ) References 41: 9 Russian, 32 Western.

**Heat Capacity of Copper-Free Oxide Superconductor  $Ba_{0.6}K_{0.4}BiO_3$  in Magnetic Fields**  
937K0191B Moscow ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 103, No 2, Feb 93 pp 605-628

[Article by G. Kh. Panova, A. A. Shikov, B. I. Savelyev, A. P. Zhernov, N. V. Anshukova, A. I. Golovashkin, A. I. Ivanova, A. P. Rusakov, Russian Scientific Center "Kurchatov Institute", RAS Lebedev Physical Institute, Moscow Steel and Alloys Institute]

[Abstract] Heat capacity of a single-phase polycrystalline  $Ba_{0.6}K_{0.4}BiO_3$  sample in the 2-50 K temperature range is examined in a magnetic field up to 16 Tesla, and without field. The coefficients of electron thermal capacity  $\gamma(0)$  is determined from magnetic field measurements, making it possible to estimate the state's density at the Fermi level. A thermal capacity step-increment  $\Delta C$  is recorded, which corresponds to the superconducting transition, exhibiting the bulk character of superconductivity. The value of  $\Delta C/\gamma T_c$  is about 1.8. Constant of the electron-phonon interaction  $\gamma$ , the characteristic phonon frequency  $\omega_{ph}$ , the effective mass, Fermi energy, group velocity  $V_F$  of the carriers, parameter of the  $\Delta(0)$  order, and the length of coherence are computed within the framework of the phonon model based on experimental values of  $\gamma$  and  $[DC]/T_c$ . It is demonstrated that the large value of  $T_c$  in  $Ba_{0.6}K_{0.4}BiO_3$  is related to the high characteristic phonon frequency and relatively large density of electron states, while  $\gamma = 0.9$  corresponds to an intermediate nature of interaction. Figures 4, table 1, references 19: 8 Russian, 11 Western.

**Electron Inelastic Light Scattering in a Superconductor and in a Normal Metal With Impurities**

937K0191C Moscow ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 103, No 2, Feb 93 pp 666-679

[Article by L. A. Falkovskiy, RAS Landau Institute of Theoretical Physics]

[Abstract] The effect of impurities and Coulomb screening on Raman scattering in a normal metal and a superconductor is examined. The potential of impurities is assumed to be short-acting, i.e. independent of the angle of electron scattering in the pulsed space. This restriction allows the obtainment of final results. It is also physically justified, since in a typical metal, screening of the impurity potential occurs at atomic distances. It is demonstrated that unlike scattering in a pure metal, the Coulomb screening plays no significant role. Without changing the threshold value of the frequency shift, the impurities have an effect on the scattering value near the threshold, as well as at large frequency values. Curves of a scattering cross section in a superconductor at low temperature as a function of frequency shift are provided. Figures 5, references 14: 8 Russian, 6 Western.

**Experimental Study of Film Condensation in Horizontal Enhanced Tubes**

937K0187A Novosibirsk SIBIRSKIY FIZIKO  
TEKHNICHESKIY ZHURNAL in Russian No 1,  
Jan 93 pp 9-18

[Article by S. I. Tsaturyan, S. S. Markelov, RAS Siberian Branch Institute of Thermal Physics; UDC 536.423.4]

[Abstract] The mechanism of fluid flow along the surface of horizontal enhanced tubes with tenons, the effects of geometric characteristics of finning and the Reynolds number of the film on heat exchange during condensation were examined and capillary attraction of fluids in lateral channels of liquid cooling systems for electronic equipment was measured. Tests were conducted using an experimental assembly whose block diagram is provided. Cooling agent R12 was used as a working liquid. The saturation temperature was maintained at  $T = 40^\circ C$ . The relationship was studied of the thermal flow density as a function of steam - walls temperature pressure. Experimental data was obtained, which indicate that employment of horizontal tubes with rectangular tenons as a heat exchange surface makes it possible to intensify the heat exchange by a factor of more than 10. A maximum of the heat exchange intensification was detected. Figures 7, tables 3, references 15: 7 Russian, 8 Western.

**Contact Resistance in Contact Nodes of Capacitors**

937K0186A Kishin FIZIKA I TEKHNIKA in Russian  
No 1, Jan 93 pp 53-56

[Article by V. P. Berzan, V. K. Rimskiy, V. A. Kobal]

[Abstract] Failure of capacitors operating in AC circuits and in pulse mode due to loss of integrity of the active elements is examined. It is very difficult in technical terms to directly measure the contact resistance or the temperatures developing in the contact connections of the capacitors. This work examines a model for contacting electrodes with a conducting metal layer. A formula for obtaining the contact resistance is derived. The results which were obtained by calculation are compared to those obtained experimentally. The results show that the formula can be used to calculate the contact resistance of spray-coated contact connections and to analyze the effect of various factors on the changing nature of this resistance.

**Compressed (Correlated) Coherent States of Electron Moving in Field of Plane Electromagnetic Wave**

937K0182A Tomsk IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: FIZIKA, Vol 36 No 2,  
Feb 93 (manuscript received 9 Jun 92) pp 45-49

[Article by I.N. Ovcharov and N.I. Fedosov, Tomsk Pedagogical Institute; UDC 530.145]

[Abstract] Compressed coherent states of a relativistic electron moving in the field of a plane electromagnetic wave are formulated so as to satisfy both completeness and orthogonality conditions. For this the Klein-Gordon equation is written in "null plane" coordinates ( $u_0 = ct - z$ ,  $u_1 = x_1$ ,  $u_2 = x_2$ ,  $u_3 = ct + z$ ) and momentum operators  $q_k$  are introduced which include momentum dispersion.

Formulation of states coherent with respect to coordinates  $x_{1,2}$  yields, upon normalization to  $(\Psi_1, \Psi_2)$  in the null plane, a set of wave functions  $\Psi(u_0, u)$  which decay exponentially along the  $u_3$  coordinate with an energy factor  $\alpha$  in the exponent. This set is complete but not yet orthogonal with respect to the quantum numbers  $z_k$ , their physical significance being that their real and imaginary parts define respectively the initial coordinate and the initial momentum of an electron. A complete set of wave functions  $\Psi(n_1, n_2, \alpha)$  orthogonal with respect to those quantum numbers and in this sense corresponding to "excited" states is obtained by operating with generation operators  $B_k +$  (introduced along with annihilation operators  $B_k$ )  $n_k$  times on the amplitudes of the respective wave functions in the original complete but not orthogonal set. Another approach is the Dirac equation and its solution by standard procedure for Dirac wave functions and their subsequent normalization to  $(\Psi_1, \Psi_2)$  in the null plane. A wave function in the complete and orthogonal  $\Psi(n_1, n_2, \alpha)$  set is the eigenfunction for momentum operators  $q_k$  with characteristic quantum numbers  $z_k$  and number  $n_k$ . When its explicit form  $\Psi(n_k)$  is expanded into the sum of two eigenfunctions  $\Psi(s_1)$  and  $\Psi(s_2)$  for a momentum operator  $q_k$  with characteristic quantum numbers  $z'_k$  other than  $z_k$  and a number  $s_k$  either smaller or larger than  $n_k$ , then each of these eigenfunctions appears with four coefficients: two coefficients characterizing momentum dispersion and two  $C(s_k)$  coefficients ( $k=1$  and  $k=2$  respectively). The square of each  $C(s_k)$  coefficient represents the probability of the corresponding electron state  $n_k$  concentrated within the neighborhood of the classical trajectory;  $a_k$  being attended by states;  $s_k$  concentrated within the neighborhood of the classical trajectory;  $a'_k$ . As to that complete and orthogonal set of wave functions, with  $n_k=0$  its Fourier transform is identical to the D.M. Volkov solution (ZEITSCHRIFT FUER PHYSIK Vol 94, 1935) except for a constant multiplier. The authors thank V.G. Vagrov for helpful discussions and valuable comments. References 7.

**Two-Dimensional Transforms for Signal Microprocessor**

937K0207A Moscow MIKROELEKTRONIKA  
in Russian Vol 22, No 3, May-Jun 93 (manuscript  
received 29 Oct 92) pp 13-19

[Article by P. A. Arutyunov, Moscow Institute of Electronics and Mathematics, State Technical University; UDC 621.382]

[Abstract] Some aspects of two-dimensional digital transforms for a signal microprocessor were discussed. The signal microprocessor was described as an abstract metering system for digital processing of images. The theory of algorithmic measurements for the unidimensional case was generalized to the multidimensional case. Two-dimensional filtration was shown to be equivalent to orthogonal algorithmic measurement. The algorithmic structure of a digital metric scale for a divisible series was discussed. Figures 3, references 8 Russian.

**New Signal Processing Technology for High-Speed Integrated Microwave Circuits**

937K0207B Moscow MIKROELEKTRONIKA  
in Russian Vol 22, No 3, May-Jun 93 (manuscript  
received 2 Dec 92) pp 37-50

[Article by V. I. Gvozdev and G. A. Kuzayev, Moscow Institute of Electronics and Mathematics, State Technical University; UDC 621.396.6]

[Abstract] The new principle of pulse modulation for high-speed integrated microwave circuits was discussed. Topological and algebraic approaches have proven fruitful not only in mathematics but also in the applied

fields of knowledge. These algebraic and topological ideas were applied to methods of signals processing and development of the basic components for high-speed digital integrated microwave circuits. The concept of nonlinear communication between the topology of the field and its distribution at the boundary of the base integrated circuit component was key. This nonlinearity was natural and was not a function of the amplitude of the actuating field. Its threshold nature was used to develop digital integrated microwave circuit components, a topological key, and NOT, AND and OR circuits. The potential speed of the topological key was estimated at 1 ps. Figures 7; references 31: 29 Russian, 2 Western.

**Study of Photoelectric Characteristics of Two-Channel Overlaid CCD**

937K0207C Moscow MIKROELEKTRONIKA  
in Russian Vol 22, No 3, May-Jun 93 (manuscript  
received 8 Jul 92) pp 63-70

[Article by V. I. Khaynovskiy, Scientific Research Institute of Physics Problems imeni F. V. Kuznetsov; UDC 621.382]

[Abstract] The photoelectric characteristics of a two-channel overlaid charge-coupled device (CCD) in the wavelength range from 0.4 to 1.1 micrometers were modeled and studied by experiment. Compared to a surface channel, it was found that an overlaid channel has higher spectral photosensitivity in the longwave range of the optical radiation spectrum ( $\lambda > 0.55$  micrometer). The possibility of developing a spectrum zonal photodetector for purposes of technical television based on a single silicon overlaid CCD chip was shown. Figures 6, references 8: 5 Russian, 3 Western.



### **Strategic Aspects of the Development of Electronic Communications in the Russian Federation**

937K0221A Moscow ELEKTROSVYAZ in Russian  
No 1, Jan 93 pp 2-3

[Article by V. B. Bulgak, Minister of Communications, Russian Federation]

[Abstract] The circumstances leading up to the Russian Federation's current communications shortfall are outlined. To remedy this situation, the Russian Federation has focused attention on the following: creation of a legal foundation for communications operations in Russia, primarily, to attract investors both foreign and domestic; provision of incentives for the development of communications; use of new forms of property and demonopolization of communication services; restructuring of the communication industry; conversion of defense industries to communication; a new tariff policy; licensing of juridical and natural persons in communications, certification of communications equipment; modernization of existing communication networks; provision of new communication services; expansion of networks. Specific projects noted include the development of international communications and the development of fiber optic transmission lines.

### **Systems of Radio Communication With Manned Spacecraft: History. Means of Improvement**

937K0221B Moscow ELEKTROSVYAZ in Russian  
No 1, Jan 93 (manuscript received 6 Oct 92) pp 12-16

[Article by V. I. Meshcheryakov; UDC 621.396.946]

[Abstract] This article provides an overview of the history of the development of radio communications with manned spacecraft. The use of shortwave communications in Gagarin's day was gradually supplanted by the use of international satellite systems. Work continued to implement new on-board stations because these satellite systems did not fully meet the needs of manned spaceflight. Practical implementation of manned spaceflight communications (for the space station) through retransmitters became possible in the mid 80s. Communication with smaller Soyuz-TM type spacecraft should be perfected in the next few years. The article outlines the development of equipment which can be easily repaired during long flights and the evolution of cosmonaut headsets. It is noted that current ground-based systems are aging, and it is becoming increasingly difficult to maintain them. This is exacerbated by economic difficulties, and this is forcing Russia to make difficult choices regarding the further development of communications. Figures 6; references 4 (Russian).

### **Satellite Communication Retransmitters: Retrospective, Problems, Means of Development**

937K0221C Moscow ELEKTROSVYAZ in Russian  
No 1, Jan 93 (manuscript received 6 Oct 92) pp 22-28

[Article by A. V. Kasatkin, A. G. Orlov; UDC 629.783]

[Abstract] This article begins with an overview of the development of satellite communication retransmitters from 1958 to the present, including tables on the Intelsat, Molniya, and Raduga series of satellites. Main problems in the development of on-board equipment are addressed. Data from the tables are compared and contrasted, and trends indicated. Prospects for the future, in terms of the development of the architecture of on-board retransmitters, are discussed. Two key trends noted are the enhancement of trunk communication lines and the extension of zone communication services to isolated and poorly accessible regions. Specific schemes for implementation of services to remote areas are described. Finally, the article addresses the disagreement on whether heavy or intermediate weight satellites should be used to provide communication services. Figures 3; tables 2; references 14 (Russian).

### **Current State and Prospects for the Development of Power Amplifiers for Satellite Communication Transmission Equipment**

937K0221D Moscow ELEKTROSVYAZ in Russian  
No 1, Jan 93 (manuscript received 15 Oct 92) pp 29-33

[Article by A. V. Tabakov, Ye. L. Bogatov, M. V. Golitsyn, N. I. Yeliseyev, G. N. Ovechki; UDC 621.396.61:621.375]

[Abstract] This article analyzes the current state of development of power amplifiers based on traveling wave tubes and transistors. These devices remain key components despite the development of semiconductor devices. These power amplifiers are designed for use in powerful radio transmitters on satellites and at ground-based stations operating in the centimeter and decimeter range. The prospects for further development in terms of improving their energy characteristics are evaluated. The prospects for developing power amplifiers in the millimeter range are examined separately. A table of power amplifiers specifications is provided. Recent advances in the development of traveling wave tubes to create power amplifiers with a power output of 300 W are described. Future research will be focused on increasing the reliability and efficiency of devices. Abroad, traveling wave tubes are being replaced with solid-state GaAs field effect transistors with a Schottky barrier. Domestic production of these devices is still being perfected. Specific examples and schematics of domestic products are given. The use of domestic bipolar transistors to improve the characteristics of transistor power amplifiers is described. A resistive diode chain may also be used for this purpose. Foreign developments in the millimeter range are outlined. Progress in this range is hindered in Russia by the virtual absence of the required range of transistors and traveling wave tubes. Figures 7; tables 4; references 23: 9 Russian, 14 Western.

### Features of Multi-Beam Satellite Communication Systems With Signal Switching

937K0221E Moscow ELEKTROSVYAZ in Russian No 1, Jan 93 (manuscript received 22 Oct 92) pp 37-40

[Article by M. I. Romanovskiy; UDC 629.783:621.391.261]

[Abstract] One drawback of satellite communication systems is that the satellite broadcasts its signal over a wide area when it needs to be received at only one point. This wastes energy. Multi-beam antennas have recently been installed in satellite retransmitters to reduce this loss. There are two advantages in this: signal energy can be reduced, thus removing the energy limit threshold on the throughput of the retransmitter (enabling communications with small inexpensive stations) and second, one can make multiple use of the operating frequencies (in different beams) which removes the frequency limit threshold on the throughput. These advantages, however, are gained by using more complex antennas and by introducing signal switching. Signal switching in the retransmitter without demodulation is explained, drawbacks indicated, and methods to circumvent them proposed. Signal switching in the video spectrum is described. It is concluded that satellite communication systems with multi-beam antennas use spatial-temporal signal switching most efficiently. Carrier signal switching using a dynamic switching matrix is predominately used in communication systems with large multi-channel high-energy stations with a high transmission speed. Signal switching in the video spectrum is predominately used in systems with small stations. It is found that demodulation of signals in the retransmitter not only simplifies the switching device design, it also increases throughput and efficiently uses the available channels and frequency band. It also reduces signal waiting time. Figures 2; references 4: 1 Russian, 3 Western.

### Connection Problems in Satellite Communications Systems Based on Low-Orbit Spacecraft

937K0221F Moscow ELEKTROSVYAZ in Russian No 1, Jan 93 (manuscript received 15 Oct 92) pp 41-43

[Article by V. V. Sokolov, V. A. Pyltsov; UDC 621.396.946.2]

[Abstract] When low-orbit satellites are used for communication systems, several satellites with different radio visibility zones are used to cover the service area. The problem arises of integrating the satellites to insure that the system is completely connected with no gaps in the service area. This is achieved with inter-satellite communication lines, ground-based retransmitters, or a combination of the two. Since there are numerous ways to achieve integration, one must evaluate the connectedness of the system and select the most effective method of integration. This article develops an algorithm to evaluate connectedness which yields an indicator for satellite communication systems using grouped satellites in circular orbits. This result can be used to compare different

systems of this type and to select a satellite grouping which provides the best connection conditions when one is designing a system with given parameters. Figures 3; references 5 (Russian).

### Multiple Use of Frequencies in Low-Orbit Satellite Communication Systems

937K0221G Moscow ELEKTROSVYAZ in Russian No 1, Jan 93 (manuscript received 15 Oct 92) pp 44-46

[Article by V. I. Meshcheryakov, V. V. Sokolov, V. A. Pyltsov, V. I. Zakharova; UDC 621.396.946.2]

[Abstract] In low-orbit satellite communication systems, mutual interference may occur when two satellites approach each other. Consequently, their signals must be separated. The problem is to maximize multiple use of frequencies in different satellites while minimizing the total number of frequency bands needed by each satellite to transmit information with a given throughput without mutual interference. This is done using spatial and/or temporal separation of signals. The method proposed here makes it possible to maximize frequency band use while minimizing the total frequency band needed for a given throughput. The method can be used for any satellite grouping structure and for any ground station antenna type. Frequency, spatial, and temporal signal separation are used in this work, but other signal separation methods may also be used (i.e., by polarization or shape) to supplement or replace these separation methods. Figures 2; tables 5; reference 1 (Russian).

### Problems in the Development of a Specialized Inertial Navigation System for Mobile Satellite Radio Communication Stations

937K0221H Moscow ELEKTROSVYAZ in Russian No 1, Jan 93 (manuscript received 15 Oct 92) pp 46-49

[Article by V. S. Vorobyev, O. P. Dyakov, G. A. Norkin; UDC 629.7.054.847]

[Abstract] In mobile satellite radio communication systems, antennas can be trained on the satellite used on an inertial navigation system. These are frequently used on aircraft and ships. However, many land-based communication systems have navigation systems which do not meet the needs of the station. Sometimes the navigation system is included in the station equipment. In existing systems, the navigation system may constitute up to 30 percent of the volume and cost of station equipment. Improvement of navigation system specifications is therefore desirable. The required specifications are outlined and the structure of a specialized inertial navigation system for mobile satellite radio communication is described. Several designs are presented, including designs which use gyroscopic angular velocity sensors. Foreign firms working on these devices are mentioned. Devices using angular velocity sensors are described. It is found that the use of specialized inertial navigation systems can significantly (by a factor of 3-10) increase

accuracy, increase the lifespan of the equipment, and reduce the weight and cost of the equipment. Figures 3; tables 2; references 5 (Russian).

**Development of Analog Microelectronic Devices for Satellite Communication Equipment**

937K0221I Moscow *ELEKTROSVYAZ* in Russian  
No 1, Jan 93 (manuscript received 6 Oct 92) p 52

[Article by Yu. Z. Annenkov, D. P. Yevdokimov; UDC 621.397.62]

[Abstract] The development of analog microelectronic devices for use in satellite communication systems is traced. The development of the analog matrix chip to create new specialized integrated microcircuits is indicated as an important step in the further improvement of analog devices. The use of analog matrix chips and their production is explained. It is stated that these devices are of key importance as they enable developers to reduce the size and weight of space equipment for satellite communication. References 2 (Russian).

**New Generation of Acousto-Electronic Frequency Selection Devices for Communication Systems**

937K0221J Moscow *ELEKTROSVYAZ* in Russian  
No 1, Jan 93 (manuscript received 15 Oct 92) pp 57-60

[Article by Yu. Z. Annenkov, P. G. Ivanov, V. M. Makarov, V. S. Orlov, A. L. Shvarts; UDC 621.396.571]

[Abstract] The use of acousto-electronic radio components (in particular, filters) based on surface or three-dimensional acoustic waves do not individually cover the spectrum of frequencies used in today's satellite communication systems. However, used together, they cover the entire required range of frequencies and passbands. This article examines the design of a new generation of surface and three-dimensional acoustic wave filters which meet the highest requirements which may be placed on them. Both wideband and narrowband filters are discussed. Integrated piezoelectric filters using three-dimensional acoustic waves and frequency selection devices which use surface and three-dimensional acoustic waves are featured. Figures 10; table 1; references 4: 3 Russian, 1 Western.

### Interconnections of Russian and Other Countries' Power Systems

937K0213A Moscow ELEKTRICHESTVO in Russian No 5, May 93 (manuscript received 2 Jul 92) pp 1-4

[Article by V.V. Yershevich and V.Yu. Kurochkin]

[Abstract] Technically most important for the reliable operation of Russian power systems are their interconnections with those of Ukraine (one 750 kV line, one 500 kV line, five 330 kV lines, total capacity 2.0 GW), of Byelarus (one 750 kV line not yet in service, two 330 kV lines, total capacity 0.8 GW), of Kazakhstan (two 1150 kV lines operating at 500 kV, nine 500 kV lines, total capacity 1.2 GW over Siberia-Kazakhstan section and 1.6 GW over Kazakhstan-Ural section), of Finland (d.c. link, total capacity about 1.0 GW), of the Baltic countries (three 330 kV lines, total capacity 1.0 GW), and of Transcaucasian countries (one 500 kV lines, one 330 kV line, total capacity 0.8 GW). Interconnections with power systems of Mongolia (220 kV) and of Turkey (220 kV) are not significant to operation of Russian power systems. The capacity of all these interconnections amounts now to 5.3 percent of total electric power generated in Russia. Power systems of two former USSR republics, Ukraine and Moldova, are interconnected with those of some Eastern European countries (two 750 kV lines, three 400 kV lines, total capacity about 2.5 GW) and of Romania only (one 750 kV line, one 400 kV line, total capacity 2.2 GW) respectively. Under consideration are two further concepts which will most appreciably influence the operation of Russian power systems. One of them is formation of an intercontinental European-Asian AC power network by not only additionally interconnecting Russian power systems through Eastern European ones to Western European ones but also interconnecting them to power systems of China. The feasibility of forming such a network and the benefits accruing not only to Russia but also to the other now independent former Soviet republics are affirmed on the basis of engineering estimates which take into account geographic factors: possibility of a 5-15 GW power transfer from Western Europe and of a 2-7 GW power transfer from China by the year 2000. The other concept is interconnection of Russian power systems with those of the US and Japan. Inasmuch as Russia is separated from these two countries by vast bodies of water, power transfer over d.c. transmission lines is obviously to be contemplated here. Figures 2; references 5.

### Electromagnetic Fields of Pulsating Currents

937K0213B Moscow ELEKTRICHESTVO in Russian No 5, May 93 (manuscript received 19 Feb 92) pp 45-49

[Article by Ye.S. Kolechitskiy, V.N. Moiseyev, A.I. Plis, and V.I. Plis]

[Abstract] The electromagnetic fields of a pulsating currents are considered in connection with the problem of

electromagnetic compatibility pertaining to radioelectronic equipment. For specificity is considered a pulsating current in a conductor, although a pulsating current in a lightning leader may also be relevant to the problem. The conductor is assumed to be a thin straight cylindrical one, in a homogeneous medium such as air or vacuum. The electromagnetic field of a pulsating current in such a conductor is described mathematically, on the assumption that the current flows concentrated along the conductor without change of pulse form and that its electromagnetic field propagates through space at the speed of light. Calculations based on this model and accordingly by the "prescribed currents" method are preferable to rigorous solution of an equation of the d'Alembert kind involving summation of the tangential field components at the conductor surface. The analytical expressions derived and the appropriate boundary conditions established according to this model for the four  $E_x, y, H_y, z$  field components are programmable for computer-aided (FISIMP program) numerical evaluation of the electromagnetic field extending from the conductor surface into space over a transient period covering and extending beyond the duration of a current pulse in the conductor. This program has already been tested for validation on the electromagnetic field of a Hertzian oscillator in both Fresnel and Fraunhofer regions (L.D. Goldshteyn and N.V. Zernov, 1971). It was subsequently used for calculating both  $E_x, y$  components of the electromagnetic field of biexponential current pulses of 1000 A amplitude (at time  $t = 0$ ) and various durations (10 ns, 13.62 ns, 100 ns) with various rise times (0.1 ns, 1 ns) in 30 m and 10 m long conductors under short-circuit, open-circuit, and matched-load (no reflections at the conductor ends) conditions, for calculating these field components at points on the conductor surface and at points in space defined in polar coordinates. Figures 9; tables 2; references 3.

### Determining Volume Density of Electromagnetic Forces in Nonlinear System by Energy Method

937K0162A Moscow ELEKTRICHESTVO in Russian No 3, Mar 93 (manuscript received 17 Apr 91) pp 32-50

[Article by Yu.V. Abramkin, candidate of technical sciences, Moscow Institute of Power Engineering]

[Abstract] One problem of electromagnetic forces in a nonlinear magnetic medium with continuously varying magnetic properties such as an electric machine where a magnetic field has been induced by currents flowing in an excitation circuit is to calculate the spatial distribution of their volume density at any instant of time according to the force equation  $f = [J \times B](H^2)(\text{grad } \mu)$ . The magnetic medium is assumed to be isotropic and hysteresis-free. All currents, including eddy currents, are tentatively known and confined within a subregion of the boundless three-dimensional space over which magnetic fields characterized by induction  $B$  and intensity  $H$  are distributed together with the field of those forces. A brief review of Maxwell's classical approach to this problem is followed by validation of that force equation

for the given kind of magnetic medium by known unconventional energy and other methods, referring to an elementary cube. The distribution of the volume density of electromagnetic forces in such a medium can accordingly be calculated on the basis of the change in its magnetic energy upon a small displacement of an elementary volume. It can also be calculated the basis of the stress tensor, referring to an elementary cube, either by differentiation of the stress tensor components in the magnetic field or by volume differentiation (volume of cube  $V \rightarrow 0$ ) of the net electromagnetic force and subsequent integration via summation of the six elementary tension forces over their respective faces. The classical first procedure is mathematically more laborious but physically more obvious. Another group of methods is based on use of special force shells ("magnetic force sheets"): cylindrical nonmagnetic ones carrying fictitious magnetic charge or magnetic ones carrying fictitious conduction current, or a combination of both kinds. When the magnetic medium is polarized, then secondary magnetic field sources are introduced and either the force function or the potential function is being used for calculating the volume density of electromagnetic forces in accordance with that classical force equation. The latter can for this case be derived from Maxwell's field equations ( $\text{curl } H = 0$ ,  $\text{div } B = 0$ ,  $B = \mu$ ) on the basis of any of the following three models: 1) Maxwell's original mathematical model of a polarized magnetic medium; 2) linearized model of such a medium with a space-invariant magnetic permeability at any instant of time; 3) small-volume ( $dV$ ) modification of that linearized model referring to an elementary sphere, with the magnetic properties artificially adjusted upon placement of secondary field sources (fictitious magnetic charges and currents) inside the small sphere. The energy method has been refined by Yu.V. Abramkin (ELEKTRICHESTVO, No 10, 1988) so that it combines two principles, namely linearization of an original nonlinear magnetic system which has anisotropic magnetic properties and small displacement (arbitrarily oriented vector  $\delta = \text{const}$ ) relative to the stationary anisotropic linearized model of that nonlinear magnetic system, with the equation of energy balance  $\delta A = \delta W$  ( $\delta A$ - work done by the elementary electromagnetic force  $dF = fdV$ ,  $\delta W$ - variation of magnetic interaction energy). With magnetic interaction energy formulated as the Lagrangian of the magnetic field ( $W = L$ ) and the volume density of the latter called the Maxwellian of a stationary magnetic field at a given observation point, the equation of energy balance becomes  $\delta W = \delta M = -dM$  and that balance can be regarded as a fundamental property of a stationary electromagnetic field. Considering that Maxwell's field equations not are consistent with the law of energy conservation but are derived from it, an efficient theory of electromagnetic forces is constructed on the basis of that energy balance. Evidently then, in the final analysis, any physically valid method of solving this problem of electromagnetic forces is essentially an energy method. Figures 4; references 18.

### Strategies for Reducing Losses and Improving Quality of Electric Energy in Power Networks: Discussion

937K0162B Moscow ELEKTRICHESTVO in Russian No 3, Mar 93 pp 73-74

[Article by L.M. Zeltsburg]

[Abstract] Reference is made to the article by Yu.S. Zhelezko in ELEKTRICHESTVO, No 5, 1992 analyzing various methods of reducing the losses and improving the quality of electric energy in power networks, of particular concern being his recommendation to lower the current density for compensation of the reactive power and the now accepted method of determining the moist economical current density. It has already been established that the optimum current density depends on the length of periods during which maximum losses occur as well as on the conductor cross-section, on the load current, on the cost of electric energy, and on the capital investment in the power line. This author supplements the analysis with numerical estimates for 35-110 kV transmission lines in conformance with Rules for Electrical Equipment Installation, considering first copper and then aluminum conductors. In the latter case conductor selection for optimum current density is shown to be, depending on all the other factors, 1.5-20 times more cost effective than conductor selection based on heating. In low-voltage networks just lowering the current density thus may be about as cost effective as compensation of the reactive power, while in high-voltage networks raising the current density above standard levels can be 1.5-2.0 times more cost effective than conductor selection based on heating. These estimates are subject to correction depending on the specific ratio of capital expenditure to cost of electric energy. References 5.

### Model of Regulating Transformer With Shunted Moving Coil of High-Temperature Superconductor Ceramic

937K0160A Moscow ELEKTROTEKHNIKA in Russian No 3, Mar 93 (manuscript received 24 Dec 92) pp 21-25

[Article by V.V. Aleksandrov, candidate of technical sciences, V.N. Yelagin, engineer, O.G. Korobov, engineer, L.V. Leytes, doctor of technical sciences, and A.I. Lurye, candidate of technical sciences, All-Russian Institute of Electrical Engineering; UDC 621.314.222.6.538.945.001.5]

[Abstract] Voltage regulating transformers of the E.T. Norris type (E.T. Norris, 1938) are manufactured in both Moscow and Tolyatti electrical equipment plants. The outstanding feature of these transformers is either a shunted moving coil (Moscow plant) or a shunted stationary coil with a moving second coil (Tolyatti plant). Inasmuch as ceramic high-temperature superconductor materials have become available, a feasibility study is underway regarding the use of such a material for the shunted moving coil. As the first model of such a

transformer has been selected a shell-type one having a 125 mm high and 74 mm wide laminated 11 mm thick E-core (0.35 mm thick laminations of electrical-grade steel) with a path-closing I-core. The center arm is 20 mm wide and the two yoke arms are each 10 mm wide. The two windows are each 105 mm high and 17 mm wide. The center arm carries two pairs of stationary coils (primary and secondary windings), each having 618 turns of 0.2 mm in diameter enamel-coated copper wire. The height of each is 38 mm, their outside diameters being 31 mm and 26 mm respectively. The shunted moving coil surrounds the cylindrical main winding tightly, free to slide but so as to stay in any desired position. Three different such coils were built: 1) three rings (overall height 22 mm, 43 mm outside and 33 mm inside diameters) of  $\text{YBa}_2\text{Cu}_3\text{O}_7$  ceramic produced by solid-phase synthesis and characterized by a low critical current density of about  $1 \text{ A/mm}^2$  at 77 K; 2) two rings (overall height 24 mm, 50 mm outside and 40 mm inside diameters) of  $\text{YBa}_2\text{Cu}_3\text{O}_7$  ceramic produced by the partial melting process and characterized by a higher critical current density of the order of  $10 \text{ A/mm}^2$  at 77 K; 3) four copper rings (overall height 22 mm, 44 mm outside and 34 mm inside diameters). With the height of these coils not exceeding 24 mm, there remained about 80 mm for sliding from the lowest position to the top is about 80 mm. The first coil was designed for evaluation

of the transformer performance in the current stabilizer-limiter mode. The second coil was designed for evaluation of the transformer performance without current limiting. The third coil was designed to serve as reference for comparison with a conventional Norris transformer, including a comparison of performance characteristics at room temperature. The model was tested in two configurations, with stationary coils and moving coil connected as in a Norris transformer and also as in a Norris autotransformer. It was in each case connected to a 50 Hz power line through a regulating autotransformer and a step-down distribution transformer. The low-temperature tests were performed with the model inside a liquid-nitrogen cryostat. Measurements were made to determine the dependence of open-circuit primary current on primary voltage with the moving coil in top and center positions, the dependence of open-circuit secondary voltage on position of the moving coil, the dependence of secondary voltage on load current under a resistive load and at a constant primary voltage, and the dependence of both primary and secondary currents on primary voltage with the moving coil in top position and with a short circuit across the secondary winding. The results indicate that such a regulating transformer with a shunted moving coil of high-temperature superconductor ceramic can be used also for stabilizing the load current during 4-10 V wide fluctuations of the primary voltage, the load current becoming more nonsinusoidal as the primary voltage rises. Figures 7; references 11.

### New Surface Structures and Spin-Flipping Phase Transitions in Anisotropic Magnetic Superlattices

937K0192A Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 57 No 7, 10 Apr 93 (manuscript  
received 24 Feb 93) pp 424-428

[Article by A.K. Zvezdin and S.N. Utochkin, Institute of General Physics at Russian Academy of Sciences]

[Abstract] New synthetic magnetic superlattices are considered on account of their heretofore unknown giant properties such as giant magnetoresistance and spin flipping. The latter phenomenon is analyzed theoretically, taking into account both volume and surface magnetic anisotropy as well the role of the free surface. As an example is selected a binary superlattice consisting of an isotropic component and a uniaxially anisotropic one, a typical such structure being a Gd/Co superlattice. Its thermodynamic potential at low temperatures is expressed as the sum of four cosine series, assuming a "saturated" magnetization of its monolayers which depends on the temperature only and intralaminar exchange interactions so much stronger than interlaminar ones so that the magnetization remains practically uniform over each monolayer. As a model for the analysis is selected a structure with identical first and last layers, thus one with an odd  $N+1$  number of layers ( $N$ -even number). The analysis then yields the exact conditions for stability of collinearly magnetized phases, these conditions depending on that number  $N+1$  as well as on three dimensionless parameters characterizing the roles of both superlattice components (1,2):  $\mu = d_1 M_1 / d_2 M_2$  ( $d_{1,2}$  - thicknesses of their layers,  $M$ - moduli of magnetization of their atomic planes),  $h = d_1 H / \lambda M_2$  ( $H$ - field intensity,  $\lambda$ - positive constant proportional to the interlaminar-exchange interaction integral, and  $K = K^* / \lambda M_1 M_2$  ( $K^*$ - constant representing the degree of second-order anisotropy,  $\lambda M_1 M_2$ - quantity proportional to the interlaminar-exchange interaction energy). The extreme case is a number of layers  $N+1$  approaching infinity and the superlattice then tending to occupy a half-space. The orientation of the magnetic field is assumed to be parallel to the superlattice plane and, without significant loss of generality, perpendicular to the axis of easy magnetization. The constitution diagram plotted in the  $(\mu, h)$ -plane reveals a "ferromagnetic" phase, "ferrimagnetic" phases I and II, a "surface flipped" phase, and in the remaining region of the  $(\mu, h)$ -plane an "angular" phase with magnetic dipole moments oriented at different angles to the magnetic field. This phase includes a "subphase" where the deviation of magnetic moments from collinearity is maximum near the surface and decreases toward zero deep underneath. Increasing the anisotropy constant  $K$  will result in successive "suppression" first of the "surface flipped" phase ( $K > 1/2$ ), then of the "ferrimagnetic" phase II ( $K > 1$ ), and finally of the "surface angular" subphase ( $K > 2$ ). In the case of a superlattice with an anisotropic surface layer the stability regions for the three "ferromagnetic", "ferrimagnetic" II, and "surface flipped" phases break up while an

"angular" phase will remain stable within a wider range of field intensity. When the anisotropy is very strong ( $K > 2$ ), these anomalous phases thus evidently vanish and the pattern becomes analogous to that of a ferrimagnetic material. Figures 2; references 7.

### Addition of Alternating Magnetic Field to Constant Magnetic Field in Type-II Superconductor

937K0192B Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 57 No 7, 10 Apr 93 (manuscript  
received 19 Jan 93) pp 439-442

[Article by V.V. Bryksin and S.N. Dorogovtsev, Institute of Engineering Physics imeni A.F. Ioffe at Russian Academy of Sciences, St.Peterburg]

[Abstract] Application of periodically alternating magnetic field to a soft type-II superconductor on top of an external constant field  $H$  much stronger than the lower critical but weaker than the upper critical is considered, of concern being evolution of the resultant magnetic induction to the steady state inside the superconductor. In the constant magnetic field alone the local magnetic induction inside the superconductor is assumed to be  $B_\infty \approx H$ . As a model for the analysis is selected a binary vortex gas, its two components having different magnetic moments and their concentration distributions being different. A system of three equations is formulated accordingly: coupled two first-order differential continuity equations describing the kinetics of the two vortex concentrations and one second-order differential equation describing the kinetics of magnetic induction. Following conversion of the first pair of equations into coupled two equations for the sum and the difference of the two vortex concentrations, this system is solved for a semi-infinitely long superconductor in a transverse magnetic field consisting of a strong constant component and a weak alternating one: an infinite Fourier series of even as well as odd sine harmonics. The solution yields a constant final magnetic induction  $B_\infty \gg H_0$  inside the superconductor when the first harmonic of the alternating field has an amplitude  $H_1$  which exceeds the lower critical field intensity  $H_{c1}$  and remains below the constant field component  $H_0$ . In the absence of a constant field the direction of the magnetic induction inside the superconductor is determined essentially by the phase difference between second and first harmonics of the alternating field, the superconductor thus behaving like a nonlinear rectifier-damper. When the alternating field has only odd harmonics, then the final magnetic induction inside is zero and thus no rectification takes place. Figures 2; references 6.

### Collective Vibrations in a Three-Band Superconductor

937K0180A Moscow TEORETICHESKAYA I  
MATEMATICHESKAYA FIZIKA in Russian Vol 95  
No 1, Apr 93 pp 101-110

[Article by V. A. Palistrant, Moldova Academy of Sciences Institute of Applied Physics]

[Abstract] Collective vibrations in a superconductor with three overlapping energy bands on the Fermi surface are examined. It is demonstrated that for certain relationships of the theory parameters, generation of two different exciton type branches is possible in addition to the acoustic branch. For collective vibrations, the anisotropic three-band system produces a Bogolyubov - Anderson mode, which corresponds to the acoustic spectrum. This mode is observed in the case of a single-band as well as three-band superconductor. The result of this study on the feasibility of attenuation of collective exciton type vibrations or generation of two different modes of such vibrations in a three-band superconductor is qualitatively different from the results in the case of a two-band superconductor. References 25: 17 Russian, 8 Western.

#### Screening Properties of Nonhomogeneous Superconducting YBaCuO Films in a Magnetic Field

937K0179A Moscow ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 103, No 4, Apr 93 (manuscript  
received 16 Mar 92) pp 1305-1321

[Article by S. A. Vitkalov, Physics Institute imeni P. N. Lebedev, Russian Academy of Sciences]

[Abstract] An experiment was performed investigating the high sensitivity of the electromagnetic response in polycrystal high-temperature superconductors to a weak external magnetic field. Of the two main models explaining the conductivity and magnetic field relationship, the one agreeing with experimental results was chosen for further investigation. This model associates the observable relationships with the presence of "effective" circuits in a nonhomogeneous superconducting medium. Investigated in the experiment was screening of an electromagnetic field at a frequency of 10 to 100 kHz with YBaCuO films in a constant or slowly varying magnetic field with intensity up to 50 oersteds at temperatures from 77 to 92 K. Expressions were derived for changes of conductivity at frequency  $\omega$  and critical current in a magnetic field. These relations vary with the magnetic field of the correction for the transition to system conductivity from superconducting circuits with

weak bonds which shunt the critical bonds of the percolation superconducting cluster. The dependency on the magnetic field for highly nonhomogeneous systems is stable toward the sample microstructure parts and is fully determined by the maximum size of the shunting circuits which is much larger than the sizes of the granules. When the sample was divided into smaller pieces, the existence of the effective circuits was immediately evident and the maximum size was measured. The value of the change in screening of the films, divided into pieces, in the magnetic field was proportional to the sizes of the individual sample pieces and thus agrees with the model. The maximum size of the effective circuits increased as the temperature approached that of the superconducting transition. Figures 6; references 16: 5 Russian, 11 Western.

#### Dipole Radiation of Surface Electromagnetic Waves in Superlattices

937K0179B Moscow ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 103 No 4, Apr 93 (manuscript  
received 2 Sep 92) pp 1371-1382

[Article by S. V. Shiyanskiy and S. A. Yatskevich, Institute of Nuclear Research, Ukrainian Academy of Sciences]

[Abstract] Surface electromagnetic waves have been observed in experiments in superlattices GaAs/Al<sub>0.2</sub>Ga<sub>0.8</sub>As when excited from the sample face. These waves can also be generated in other optical processes such as luminescence and Rayleigh and Raman scattering. The theoretical study of these processes leads to the problem of radiation of the point dipole in the superlattices. The problem of radiation of these waves by a dipole located near the boundary of a homogeneous medium and a semi-infinite superlattice was solved. Expressions were derived to compute the intensity of the radiation of the surface TE and TM waves. Wave radiation intensity is dependent on dipole position and the relation is determined by an interference multiplier which can cause full suppression of TE wave radiation. Conditions were derived for the existence of the waves. Relationships between wave intensity and frequency, superlattice parameters and dipole location were found. Figures 6, references 7: 3 Russian, 4 Western.



### Effect of Armature Reaction in Linear Permanent-Magnet Motors With Controllable Current Layer

937K0212A Kiev *TEKHNICHESKAYA ELEKTRODINAMIKA* in Russian No 1, Jan-Feb 93  
(manuscript received 6 Jul 92) pp 39-41

[Article by A.A. Afonin, doctor of technical sciences, P. Belyy, and S.L. Fursenko, Institute of Electrodynamics at Ukrainian Academy of Sciences, Kiev; UDC 621.3.045.2:621.313.8.001.57]

[Abstract] A single-sided linear motor with a stationary permanent-magnet field and a moving armature which carries a single-layer winding on an ironless core is considered, of concern being the effect of transverse armature reaction on the main magnetic flux. A continuous straight sequence of NS-NS pole pairs formed by identical pieces of Fe-Nd-B permanent-magnet material and aligned in the direction of armature motion establishes a spatially periodic excitation field, while the armature winding carries a controllable current flowing in the same direction. First the performance of the magnetic system in such a motor is analyzed approximately but adequately, assuming a constant magnetic permeability of the inductor steel, a negligible magnetic leakage flux, and a uniform axial distribution of the armature winding. Engineering design calculations, referred to one pole pitch, take into account that the magnetic induction vector and the field intensity vector are here oriented in the same direction across the working air gap and in opposite directions along the magnet structure. The effect of armature reaction on the main magnetic flux is evaluated with the aid of two equations, one describing the demagnetization curve for the permanent magnet and one describing the field dependence of the induction in the air gap. Appropriate simultaneous solution of these equations yields expressions for the magnetic induction under the two pole edges, which indicate that the magnetic field generated by the armature current distorts the main field by boosting it under the leading edge and weakening it under the trailing edge. As long as these two distortions are of the same magnitude, the total magnetic flux across the air gap is the same with a sufficiently weak current as without a current in the armature winding. As the armature current is increased, however, its demagnetizing effect becomes stronger so that the induction and thus the total magnetic flux will decrease. An effective countermeasure is widening the air gap. These conclusions have been confirmed on an experimental prototype motor with grade-Nm30Di6R permanent magnets (remanence 1.05 T, coercive force 750 kA, pole height 10 mm, pole face  $30 \times 30 \text{ mm}^2$ ), an 8 mm wide working air gap, and a 6 mm thick layer of armature winding (429 turns of wire 0.4 mm in diameter, electrical resistance 8.6  $\Omega$ ) carrying a current of 2 A. Figures 2; references 2.

### Basic Technological Aspects of Organizing Small-Scale Production of 300-600 W Electric Household Motors Under Present Manufacturing Conditions

937K0212B Kiev *TEKHNICHESKAYA ELEKTRODINAMIKA* in Russian No 1, Jan-Feb 93  
(manuscript received 16 Oct 92) pp 45-47

[Article by V.S. Sysoyev, "Elektrotyazhmash" (Heavy Electric Machinery) Manufacturing Plant, Kharkov; UDC 621.313.333.044]

[Abstract] Production of 300-600 W 3000 rpm electric household motors is proposed, organization of the technological process being outlined which will match present manufacturing techniques with the motor design. Under consideration are squirrel-cage induction motors with cast-aluminum (aluminum alloy) rotors running on two radial ball bearings, one in each of two cast-aluminum (aluminum alloy) end shields, and with wound stators whose laminated iron cores consist of two equally long stacks twisted  $180^\circ$  relative to one another. A special lathe with a hydraulic drive is set up for rough and fine turning of cylindrical surfaces. Cores are stacked in a special vertical press. Assembly is done in work stations with the aid of manual tools. Complete motors are tested in a special stand equipped for measuring the stator winding resistance, the no-load current and power losses, the locked-rotor current, and the rotor speed. The stator terminals are then marked appropriately in accordance with the direction of rotation. The production line is designed for an annual output of 100,000 motors. It covers a 540  $\text{m}^2$  floor area, employs 214 persons, and requires a 60 kW power source for operation. Figures 4.

### Personal Computers Used To Code Parts

937K0201A St. Petersburg *PRIBORY I SISTEMY UPRAVLENIYA* in Russian No 3, Mar 93 p 12

[Article by E. A. Pil, St. Petersburg Institute of Precision Mechanics and Optics; UDC 681.3.04:658.512.22.011.56]

[Abstract] In machine and instrument building, parts must be coded and classified. A BASIC program (KOD) was developed for IBM compatible personal computers to code parts in classes 71-75. The program occupies 214 bytes of RAM. The program includes more than 100 drawings and several dozen tables to facilitate coding. A menu is provided for the user to select the class of part to be coded. A brief description of parts in that class is also offered. The user gives the maximum length and largest external diameter of the part, and the program uses this information to further narrow down the number of choices. The user is supplied with figures or tables to further refine the choice. Once the user selects a code from a table, the part number and name is displayed on screen and may be printed.

### Methods and Devices To Monitor the Topological Characteristics of a Set of Objects in Industrial Vision Systems

937K0201B St. Petersburg PRIBORY I SISTEMY  
UPRAVLENIYA in Russian No 3, Mar 93 pp 29-30

[Article by A. L. Drzhevetskiy, V. N. Kontishev, Penza;  
UDC 681.2:326.7]

[Abstract] Various devices which may be used or which are commonly used in quality control of electronic parts and devices are discussed. The advantages and drawbacks of analysis by comparison with a standard are described. Structural-linguistic methods of image recognition are proposed for quality control. In these methods a matrix representing a structural description of the object is constructed. One can limit the number of characteristics considered to speed processing time. The process is mathematically examined. The combination of the structural-linguistic approach and methods of image selection are shown to be a powerful means of real-time quality control. References 10 (Russian).

### Automated System To Monitor the Mounting of Printed Circuit Boards AMTs 14320

937K0201C St. Petersburg PRIBORY I SISTEMY  
UPRAVLENIYA in Russian No 3, Mar 93 pp 35-37

[Article by A. A. Milova, M. F. Nenarokov, M. M. Reznik, Ye. V. Fink, S. N. Nikitin, Kontrolpribor Scientific Research Institute, Penza; UDC 621.3.049.08.75.001]

[Abstract] The Kontrolpribor Scientific Research Institute in Penza has developed an automated system to monitor the mounting of printed circuit boards, the AMTs 14320. The system is designed to automatically monitor the mounting of large one-layer, two-layer, and multi-layer printed circuit boards, as well as the layers of multi-layer boards in mass production. A distinguishing feature of the system is the use of a device which combines a switch and a universal contacting field, which substantially reduces user costs associated with system adaptation to a specific printed circuit board. A schematic is offered. The system uses an IBM PC/AT-286 compatible computer and software on floppy disks. Four operating modes are provided: a self-test mode, an automatic programming mode which prepares for testing, a testing mode, and an editing mode to revise the model produced in the preparation mode. The contacting scheme is described and specifications provided. Figures 4.

### Experience in Using Glues in Instrument Building

937K0201D St. Petersburg PRIBORY I SISTEMY  
UPRAVLENIYA in Russian No 3, Mar 93 pp 38-39

[Article by A. M. Galchutkin; UDC 621.792.053]

[Abstract] The advantages of using glue over other forms of attachment, such as welding, are enumerated. The domestic PKS-135 and PKS-175 glues are described, as is the use of the Anaterm-IV (An-IV) anaerobic universal sealant. This sealant is used not only as a sealant, but also as a thickener. Anaerobic sealants are multi-component liquid compounds which can remain in their initial state for a long time, but which rapidly solidify at 50-100°C with the formation of a durable polymer after the sealant penetrates the micropores of the parts and after oxygen access is cut off. It is also possible to solidify anaerobic sealants at room temperature. An example of the procedure for using anaerobic sealants is presented. A more ecologically clean glue (compared to epoxy-like glues), Styk 3-8, is described. Styk 3-8, a multi-component compound, uses an elastic polyurethane glue and can be used at -60 to +80°C. The Vidal-B-2M compound has been developed to bond polyurethane to aluminum.

### Technique of Experiments for Investigation of Single Failure Events in Digital Integrated Circuits

937K0178A Moscow PRIBORY I TEKHNIKA  
EKSPERIMENTA in Russian No 1, Jan-Feb 93  
(manuscript received 6 Mar 92, after completion  
8 May 92) pp 123-127

[Article by Ye.R. Astvatsaturyan, A.A. Belyanov, K.G. Yeliseyev, O.A. Kalashnikov, S.A. Kurnayev, and A.I. Chumakov, Experimental-Scientific-Industrial Association "Specialized Electronic Systems, Moscow; UDC 621.382]

[Abstract] A technique of physical experiments is considered for investigation of single failure events in digital integrated circuits following absorption of energy from individual incident ionized nuclear particles. The source of nuclear particles for these experiments must emit a flux of  $10^3$ - $10^5$  ions/(cm<sup>2</sup> x s) intensity and their mean free path must be longer than the distance to p-n junction, thus longer than 3 μm. The source must emit particles so that they will impinge on the circuit all in one direction at various angles of incidence, with an energy adjustable from a few to hundreds of megaelectronvolts. The linear density of their ionization loss must exceed 1000 MeV/cm. These requirements are most satisfactorily met by cyclotrons. Experiments can be and are controlled by a microcomputer such as the IBM PC-XT. One test stand with an ITs-100 cyclotron used for inspection of random-access memories includes a 0.1-0.2 μm thick gold foil which attenuates the incident ion flux by scattering the ions into two symmetrically branching channels: through one channel onto the integrated circuit under investigation and through the other channel onto a semiconductor-type ion detector which feeds signals to a spectrum analyzer. For inspection of the integrated circuit, the latter is interactively interfaced with a functional monitor. Both monitor and spectrum analyzer are interactively interfaced with a control microcomputer. Monitors built on KR1816VYe32 and KR1816VYe35

single-chip microcomputers facilitate simple diagnostic testing of integrated circuits such as static and dynamic random-access memories with up to 1 Mbit capacity operating in the 1-2-4-8 code, by storing the addresses of their first 70 failing memory cells. The drawbacks of using cyclotrons are their inadequate accessibility, high cost, and complicated operation. During operation by remote control, moreover, problems arise due to electromagnetic interference and especially so with ion beams of low intensity. Other sources of nuclear particles adequate at least for preliminary experiments with integrated circuit are isotope sources. Such a source is placed inside a vacuum chamber facing the integrated circuit. For this application are recommended sources of 4-10 MeV  $\alpha$ -particles ( $^{210}\text{Po}$ ,  $^{239}\text{Pu}$ ,  $^{241}\text{Am}$ ) and sources of fission fragments from 30-100 MeV heavy nuclei ( $^{252}\text{Cf}$ ). These sources are almost as good as a cyclotron, but only for a restricted class of ions and a certain energy range. Two different sources of heavy nuclear particles delivering each a flux of 3 ions/(cm<sup>2</sup> x s) and also an ITs-100 cyclotron were used for testing 4K x 1 CMOS random-access memories. The number of failure events was in each case found to be proportional to the length of bombardment time. The main drawbacks of using isotope sources are difficulties in attaining target-oriented action of nuclear particles on individual microcircuit fragments and in accurate determination of the switching threshold for each. Free of these difficulties are picosecond lasers with sharp focusing of the beam, as demonstrated by use of a 1.06  $\mu\text{m}$  laser with compression to a picosecond monopulse, with a set of attenuating filters, and with focusing of the beam within a 10  $\mu\text{m}$  wide spot. In testing a RAM up to its breakdown threshold, any loss of ionization energy by individual nuclear particles and the resulting action on that RAM could be simulated with the aid of this laser for a determination of the switching thresholds for individual RAM segments. Use of a laser beam for inspection of digital integrated circuits by simulation of single failure events is quite promising, despite limitations due to beam divergence, reflection of radiation by inhomogeneities, and the impossibility of tracking nuclear particles under the metal coating. The authors thank A.Yu. Didyk, V.A. Skuratov, and D.V. Akinshin at the Joint Institute of Nuclear Research in Dubna for assistance in the experiments. Figures 4; references 5.

### Frequency Synthesizer for Ultrahigh-Frequency Automatic Control Systems

937K0178B PRIBORY I TEKHNIKA

EKSPERIMENTA in Russian No 1, Jan-Feb 93  
(manuscript received 20 Feb 92) pp 159-163

[Article by A.V. Nikonov and G.V. Nikonova, Omsk Polytechnic Institute; UDC 621.373-187.4]

[Abstract] A synthesizer of 64-1024 MHz frequencies for phase-lock automatic frequency control systems is described which operates in the active coherent mode for the upper part of the frequency range covering an at least 2:1 ratio of maximum to minimum frequencies ratio and in the passive coherent mode downward. The tunable 512-1024 MHz oscillator includes a 2T647A microwave transistor in common-collector connection ensuring minimum oscillator noise, a series tank circuit (two varicaps, two 2A611A microwave diodes, inductance coil), and a 0.3  $\mu\text{H}$  choke (conductor passing through M1000 ferrite ring) between collector and base. Its output signal passes through a variable-divisor frequency divider preceded by a 20/22 variable-divisor input counter and proceeds to a pulsed phase detector, the overall divisor having been set by code from the main line. In the detector, which has two D-triggers and voltage amplifiers with open collector circuits, the converted oscillator signal mixes with a 2.56 MHz reference signal. The error signal is then fed back to the oscillator, after passage through an integrator with a proportionally integrating output filter, and the frequency-control loop is thus closed. Spurious passage of the reference signal through the integrator is prevented by a 2.56 MHz rejection filter. The oscillator also sends a harmonic signal directly to a GaAs IC shaping device which converts it into a pulse signal so that amplitude nonuniformity is eliminated. The pulse signal proceeds to a binary counter followed by a multiplexer which selects the counter output signal appropriate for a given frequency subrange. The divisor of the frequency divider can be varied from 200 to 400 in steps of 4, the oscillator frequency correspondingly changing from 512 MHz to 1024 MHz in 10 MHz steps. With the proper multiplexer settings and divisors of the binary counter, the synthesizer can operate as carrier of the phase shift angle in systems operating with clock frequencies from tens of kilohertz to hundreds of megahertz. The synthesizer has been tested, particularly for phase noise in the oscillator. The magnitude of the synthesizer output signal is within the 0.1-0.2 low range and the 0.9-1.5 V high range. The overall r.m.s. time noise in a 1 GHz synthesizer output signal does not exceed 1 ps. Figures 4; references 5.

### Nonlinear Self-Consistent Theory of Free Electron Lasers

937K0198A Kiev UKRAINSKIY FIZICHESKIY  
ZHURNAL in Russian Vol 38 No 2, Feb 93  
(manuscript received 30 Mar 92) pp 198-203

[Article by V. V. Kulish, S. A. Kuleshov, Sumy Physico-technical Institute, Sumy; UDC 537.86+621.373]

[Abstract] It is shown that in parametrically-resonant interaction of electromagnetic waves with the plasma of a relativistic electron beam there is nonlinear generation of an electric field which, under certain conditions, may act as an independent saturation mechanism to amplify the signal wave in nonisochronous free electron lasers. This phenomenon is closely related to the capture effect. In isochronous systems with optimal electrostatic support or variation in the pump wavelength, it is shown that the effect of this saturation mechanism, like all others, can be completely suppressed. The article also sums up the results of four previous articles in this series on the development of a nonlinear self-consistent theory of free electron lasers which uses the averaged kinetic equation method with a slowly changing amplitude to achieve consistency. Figures 4; references 9 (Russian).

### Effect of Critical Fluctuations on Phase Transition in a Superconductor With Mixed Pairing

937K0198B Kiev UKRAINSKIY FIZICHESKIY  
ZHURNAL in Russian Vol 38 No 2, Feb 93  
(manuscript received 27 Mar 92; after revision  
5 May 92) pp 281-286

[Article by A. E. Filippov, A. V. Radiyevskiy, Donetsk Physicotechnical Institute, Donetsk; UDC 539.2]

[Abstract] This article examines the critical behavior of high-temperature superconductors with anisotropic s+d pairing. The examination of this behavior is based on the Ginzburg-Landau functional, which describes the real situation in exotic superconductors and may in principle describe high-temperature superconductor systems. It is shown that this behavior corresponds to the universality class of a model with interacting multi-component order parameters. It is found that even in the first  $\epsilon$ -approximation, the renormalization group equation does not have a stable immobile point. The possibility of fluctuation-induced first-order phase transitions is discussed. References 35: 15 Russian, 20 Western.

### Telescopic System for Generating Laser Beams With Phase Conjugation Compensation for the Output Path

937K0195A Moscow KVANTOVAYA ELEKTRONIKA  
in Russian Vol 20 No 4, Apr 93 (manuscript received  
16 Feb 93) pp 317-318

[Article by M. V. Vasilyev, V. Yu. Venediktov, A. A. Leshchev and P. M. Semenov, State Optical Institute of

Electronics and Mathematics, State Technical University; UDC 681.7.067.23:621.373.826]

[Abstract] Design principles and results of experimental modeling of optical system for generating light beams in which distortions introduced by the errors of all the components in the output path (main and secondary mirrors of output telescope) are compensated for by using phase conjugation were discussed. The system was modeled in an experiment with a CO<sub>2</sub> laser (wavelength = 10.6 micrometers). The main mirror, with six segments, had a diameter of 400 mm and focal distance of 2,009 mm. The system operated with compensation at the diffraction limit of resolution when the segments were tilted relative to each other at angles up to 0.25 mrad and the plunger shifted up to 150  $\lambda$ . The system radiation pattern was stable when the main mirror was tilted at angles up to 0.4 mrad. Numerical modeling produced similar results. Figures 1, references 6: 4 Russian, 2 Western.

### Highly Stable Single-Frequency Solid-State Lasers

937K0195B Moscow KVANTOVAYA ELEKTRONIKA  
in Russian Vol 20 No 4, Apr 93 (manuscript received  
29 Jan 93) pp 322-344

[Article by N. V. Kravtsov and O. Ye. Naniy, Scientific Research Institute of Nuclear Physics, Moscow State University, imeni M. V. Lomonosov; UDC 621.373.8.038.825]

[Abstract] Theoretical and experimental research aimed at development and production of highly stable, single-frequency, continuous wave, solid-state lasers was reviewed. Design features, methods and basic characteristics of the new generation solid-state lasers, miniature monolithic solid-state lasers with a semiconductor pump (chip-lasers), were described. Topics discussed include physical and technical sources of instability, methods of obtaining single-frequency oscillation, linear and ring lasers, chip laser radiating frequency control and absolute stability. Figures 13; references 197: 86 Russian, 111 Western.

### High Orders of Continuum Approximation in the Description of Supersonic Large-Amplitude Acoustic Solitons

937K0194A St. Petersburg FIZIKA TVERDOGO TELA  
in Russian Vol 34 No 11, Nov 92 (manuscript received  
7 Feb 92; after revision 8 May 92) pp 3357-3365

[Article by S. A. Beklemishev, V. L. Klochikhin, L. Ya. Karpov Physicochemical Institute, Moscow; UDC 539.21:678.01]

[Abstract] This article analytically studies a solution of an equation of motion in the form of isolated waves in a one-dimensional lattice with arbitrary anharmonic

potentials of interatomic interaction, including Morse, Lennard-Johns, and Toda interactions. High orders of continuum and quasi-continuum approximation are examined. Their convergence to one another is shown. Various approximate solutions are compared with an exact solution for a Toda lattice. It is shown that the solution found in this article is more exact than those obtained previously. The correctness of this solution for other interatomic potentials is verified with dynamics calculations done on a computer. The applicability conditions of continuum approximations of a different order are determined, and it is shown that for these approximations it is impossible for an elongated soliton to exist in an anharmonic chain with a realistic interaction potential. For other approximations the dependence of the amplitude and width of a soliton on its speed is found, and in the case of an external load, the dependence of the width of the soliton on uniform static deformation of the chain. Figures 5; references 21: 8 Russian, 13 Western.

#### Electron Localization and Optical Properties of Superlattices in an Electric Field

937K0194B St. Petersburg FIZIKA TVERDOGO TELA in Russian Vol 34 No 11, Nov 92 (manuscript received 26 Jun 92) pp 3501-3510

[Article by A. G. Zhilich, St. Petersburg State University; UDC 539.537.535]

[Abstract] This article studies the optical properties of a layered GaAs-AlGaAs type superlattice heterostructure in a strong longitudinal electric field. The effective mass approximation is used. The one-dimensional superlattice is modeled as a series of potential wells separated from each other by  $\delta$ -shaped barriers. An advantage of this model is that all calculations can be performed analytically. The dependence of the spectrum on the electric field and on the superlattice parameters is tracked. The energy spectrum of electrons and holes is found. The absorption of light by the superlattice with the formation of electron-hole pairs or the formation of a two-dimensional exciton is studied. The expressions which are obtained for the absorption coefficient make it possible to track the evolution of the energy spectrum and wave functions of the current carriers as the electric field increases. It is shown that in strong fields (50-100 kV/cm) virtually complete localization of the wave functions of electrons and holes is achieved in one elementary cell of the superlattice, and an absorption spectrum is formed by the transitions between the levels of holes and electrons in isolated potential wells. The results obtained here can be used in qualitative and quantitative analysis of experimental data on the optical absorption spectra or photocurrent spectra in layered semiconductor heterostructures. References 11: 3 Russian, 8 Western.

#### Laser Annealing of High-Temperature Superconductors

937K0194C St. Petersburg FIZIKA TVERDOGO TELA in Russian Vol 34 No 11, Nov 92 (manuscript received 10 Jan 92) pp 3588-3590

[Article by Ya. O. Dovgiy, I. V. Kityk, R. V. Lutsiv, Kontsern-Elektron Joint Stock Company of the Lvov Materials Scientific Research Institute; UDC 535.37]

[Abstract] The researchers used 0.96-4.55  $\mu\text{m}$  pulsed lasers to irradiate the surface regions of high-temperature superconductors to study the behavior of critical currents. The annealing and quality control processes are described. The laser irradiation showed that in the energy density range from  $0.9 \times 10^4$ - $1.6 \times 10^4$  J/m<sup>2</sup> a melted and recrystallized surface is generated with surface smoothing. An unusual nonsuperconducting phase appeared 3  $\mu\text{m}$  from the surface. This is explained by melting without subsequent crystallization, with resultant oxygen depletion. The depth distribution of the critical current is analyzed. It is unambiguously confirmed that near infrared laser pulses cause laser annealing of the surface layer of samples, which leads to a significant increase in critical currents. This process is characterized by anisotropy and is more distinct in ceramic samples. Figures 3; references 7: 4 Russian, 3 Western.

#### Methodes and Equipment for Spectral and Kinetic Studies of a High Time Resolution. (Review)

937K0193A Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 58, No 1-2, Jan-Feb 93 pp 13-28

[Article by Ye. S. Voropay, V. V. Danilevich, A. F. Chernyavskiy, Savchenko Scientific Research Institute for Applied Physical Problems, Minsk; UDC 535.37:537.86]

[Abstract] A review is made of the most promising methods developed by the authors of this article and A. N. Savchenko for analysis of spectral and kinetic characteristics of luminescence, based on stroboscopic transformation and statistical analysis of non-steady-state flows of luminescence, formed by pulsed excitation of the examined objects. A spectrometric complex has been developed for registration of spectral and kinetic characteristics of optical processes when studying the properties of atoms, molecules and crystals by the methods of non-linear optics and spectroscopy. A block diagram of the complex is provided and its functioning is described. Functioning and composition of a computer-aided measurement and control system CAMAC is described. This system is employed to provide measurements of spectral and kinetic characteristics of long lasting luminescence. Structural composition, fundamental parameters and functioning of a pulsed spectrofluorimeter, which was

also developed by the authors, is discussed. Block diagrams of its optical and electronic system and the system for a multichannel statistical analysis in real time are included.

### The Effect of Pumping Radiation Polarization on the Generation Characteristics of Dye Lasers

937K0193B Minsk ZHURNAL PRIKLADNOY  
SPEKTROSKOPII in Russian Vol 58, No 1-2,  
Jan-Feb 93 pp 108-113

[Article by L. I. Burov, A. V. Zhvarevskiy, A. P. Klishchenko, I. N. Kozlov, A. P. Listopad; Belarus State University, Minsk; UDC 621.373]

[Abstract] In order to reduce to a minimum the saturation effect, radiation polarization was experimentally studied in the near threshold region of the pumping energy. The study was made for two pumping geometries - longitudinal and transverse. Different concentration rhodamine 6Zh solutions in a laser with an isotropic resonator made of a rectangular quartz cuvette were used. The generation power and the laser radiation polarization was measured using a device whose diagram is provided. Pumping was carried out by polarized 30 ns wide radiation pulses of Nd-laser with a pulse repetition rate of 12.5 Hz and wavelength of  $\lambda=532$  nm. The experimental data on the laser radiation polarization are well correlated with the earlier published data, but a fundamental difference was demonstrated in the generation efficiency. An independent theoretical analysis was carried out based on the standard methods. After some approximations and assumptions, relationships were computed of the relative generation power and the radiation polarization power as a function of the degree of pumping radiation ellipticity for longitudinal and transverse configurations. It was demonstrated that the radiation generation forming mechanism is governed by a noncoherent mode mixture of all possible polarizations, independent of the radiation polarization and the geometry of pumping. Figures 4, references 12: 10 Russian, 2 Western.

### Amplitude Focusing in Open Optical Cavities

937K0193C Minsk ZHURNAL PRIKLADNOY  
SPEKTROSKOPII in Russian Vol 58, No 1-2,  
Jan-Feb 93 pp 166-173

[Article by A. P. Khapalyuk, Savchenko Scientific Research Institute for Applied Physical Problems, Minsk; UDC 621.372.413:535]

[Abstract] It is demonstrated that a wave theory can be constructed in a paraxial approximation, which describes phase-stable as well as phase unstable open optical resonators. A two-dimensional resonator model, in a form of two spherical mirrors where space between them is filled by an active material, is used for studying the feasibility of paraxial approximation when designing open resonators with diffraction losses. A diagram of this

resonator, and the selected coordinate system is described, and the parameters are specified. Assuming that under conditions of steady-state generation, the eigenmode of the resonator is a superposition of two gauss-hermitian beams propagating in the opposite direction, the problem is solved mathematically. A functional relationship of the derived expressions for the field is examined and their physical interpretation is provided. With no amplitude focusing, the generation threshold is independent of the mirror's curvature, because the phase focusing is not related to the beam energy losses. With amplitude focusing, the mirror's parameters affect the generation threshold differently for different modes. Figures 2, references 5 Russian.

### Limitations in Implementing Multistage Laser Amplifiers

937K0185A Minsk INZHENERNO-FIZICHESKIY  
ZHURNAL in Russian Vol 64 No 1, Jan 93  
(manuscript received 20 Aug 91) pp 63-66

[Article by V. V. Lobachev and V. L. Moshkov, Mechanics Institute, Saint Petersburg]

[Abstract] A master oscillator-amplifier is the most acceptable way of developing high-power lasers. But the requirement for optical uniformity of the active medium imposes a limit on the length of the amplifier along the light propagation path. The effect of the inverse characteristics of the active medium and the degree of integral nonuniformities in it on the energy indicators of laser radiation in the zone of use was analyzed jointly. Intensity is described in an approximation of linear and saturated amplification. Distortions in the active medium are accounted for by wave front spreads. Combined analysis of the inverse indicators and optical quality of the active medium allowed finding the optimum number of amplification stages of a laser for ensuring maximum radiation power density in the zone of use. The active medium of a pump CO<sub>2</sub> sputter-ion amplifier with excitation by direct current was considered as an example. Interferometric diagnostics of the stream and measurement of indicators of amplification of the weak signal showed that nonuniformity of density brought Shtrel's number down to 0.95 (wave front dispersion is 0.05) per meter of active medium while the amplification averaged 0.4 1/m. When amplification in this amplifier is not saturated, a four-pass scheme for passage of radiation in the medium with total extent through the medium of 4 m should be constructed to obtain maximum density of power in the zone of use when generating output radiation. Under the same conditions, saturation allows ensuring maximum density of power when the total extent through the medium is 3 m. Increasing the extent to 5 m in both cases causes reduction in power. Figures 4; references 4: 3 Russian, 1 Western.

**Measuring Brightness Temperature by Wideband Pyrometer**

937K0185B Minsk INZHENERNO-FIZICHESKIY  
ZHURNAL in Russian Vol 64, No 1, Jan 93  
(manuscript received 21 Jan 92) pp 67-72

[Article by V. N. Snopko, Institute of Physics imeni B. I. Stepanov, Byelarusian Academy of Sciences, Minsk]

[Abstract] The concepts of integral brightness temperatures measured by an optical pyrometer with a wideband spectral channel were introduced. Brightness pyrometry is based on comparing the signals of a pyrometer sighted on the object under investigation and the standard black body radiator. When the pyrometer spectral channel is sufficiently monochromatic, the spectral densities of the energy brightness of the object and the standard are compared which allows computing the brightness temperature. The relation of these temperatures among themselves and with the thermodynamic was shown. Temperatures were compared and analyzed using a grey body sample. The transition to monochromatic parameters was set for a wavelength of 0.63 micrometers. Calibration temperature was 1,000 K. In the range studied, the weighted average temperatures exceeded all other conventional temperatures. Using the effective

brightness temperature was considered most expedient. Figures 1, references 5: 3 Russian, 2 Western.

**Recording of the Wave Front Reversal-Holograms at the Junctions in an Excited Channel of Rhodamine 6-Zh Dye**

937K0183A Minsk VESTNIK BELORUSSKOGO  
GOSUDARSTVENNOGO UNIVERSITETA: FIZIKA,  
MATEMATIKA, MEKHANIKA in Russian No 1,  
Jan 93 pp 9-12

[Article by Dzhikhad Addasi, A. L. Tolstik, A. V. Chaley; UDC 535.34]

[Abstract] Wave front reversal (WFR) was obtained under four-wave interaction due to absorption from excited singlet level of rhodamine 6-Zh dye. The transition of molecules into the excited state was accomplished by the laser second harmonic on an aluminum-yttrium garnet. The frequencies of waves participating in the process of four-wave WFR were in the absorption band of the excited channel. A block diagram of the experimental setup and graphs of the obtained reverse wave reflection coefficient as a function of the optical pumping intensity and the pumping waves are provided. Measurements of the four-wave WFR energy efficiency were made with a system using photo diodes, and pulsed digital voltmeters. Figures 3, references 2 Russian.

**Resonant Excitation of Vibrational Modes in the Microrelief Surface of GaAs**

937K0197 St. Petersburg FIZIKA TVERDOGO TELA in Russian Vol 35 No 1, Jan 93 (manuscript received 9 Apr 92) pp 15-20

[Article by N. L. Dmitruk, N. V. Kotova, Ye. V. Podlisniy, T. R. Barlas, Institute of Semiconductors, Academy of Sciences of Ukraine, Kiev; UDC 621.383.41]

[Abstract] Infrared spectroscopy and raster electron microscopy are used to study the dynamics of the change in intensity of natural oxide vibrational bands in GaAs when the intensity depends on the morphology of the surface microrelief and the oxide thickness. The observed increase in the intensity of vibrational modes can be tentatively attributed to Anderson localization of infrared light in a randomly disordered surface structure which is formed due to anisotropic etching. Methods of creating microrelief are described. The reflection spectrum and its dynamics in the process of anisotropic etching are studied. The effects of anisotropic etching are then analyzed. A possible mechanism for increasing the vibrational bands is described. Figures 3; references 10: 7 Russian, 3 Western.

**Experimental Field Effect Transistor Based on Polytype 4H Silicon Carbide**

937K0190 St. Petersburg FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 27 No 1, Jan 93 (manuscript received 15 May 92; signed to press 26 Jun 92) pp 102-107

[Article by M. M. Anikin, P. A. Ivanov, V. P. Rastegayev, N. S. Savkina, A. L. Syrkin, and V. Ye. Chelnokov, A. F. Ioffe Physicotechnical Institute, Russian Academy of Sciences, St. Petersburg]

[Abstract] For the first time, a field effect transistor based on polytype 4H silicon carbide has been manufactured and studied. The transistor is an n-channel transistor with a gate in the form of a p<sup>+</sup>-n junction. The production of SiC-4H single crystals is described. The output characteristics correspond well to the model of a "smooth" channel. This mode was developed by Shockley for a stripped field effect transistor. The electric parameters are compared with the parameters of a similar transistor based on polytype 6H silicon carbide. For a comparable controlling field, the mutual conductance of the gate of the Si-4H transistor exceeds the mutual conductance of the SiC-6H transistor due to the channel's higher specific electric conductivity. Figures 4; tables 2; references 8: 7 Russian, 1 Western.

**Deep Traps in n-GaAs Bombarded by Fast Neutrons**

937K0188A St. Petersburg FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 27 No 2, Feb 93 (manuscript received 24 Mar 92, signed to press 14 Jul 92) pp 260-264

[Article by V.N. Brudnyy, N.G. Kolin, and A.I. Potapov, Siberian Institute of Engineering Physics at Tomsk State University imeni V.D. Kuznetsov, Tomsk]

[Abstract] An experimental study of deep traps in epitaxial n-GaAs layers bombarded by fast neutrons was made, such layers having been produced by the chloride method. Measurements by the method of transient capacitive spectroscopy were performed on Ti/n-GaAs/n<sup>+</sup>/GaAs structures with  $n \approx (2-3) \times 10^{15} \text{ cm}^{-3}$  and  $n \approx 2 \times 10^{18} \text{ cm}^{-3}$  concentrations, after they had been bombarded by a neutron flux of  $10^9 \text{ cm}^{-2} \text{ s}^{-1}$  intensity carrying not faster than 0.3 MeV neutrons in the peripheral channel of a water-moderated water-cooled reactor (cadmium number  $N_{\text{Cd}} = 10$ ) at a not higher than 70°C temperature. The spectra of these n-GaAs layers before bombardment revealed two kinds of traps: X1-traps in concentrations up to  $5 \times 10^{12} \text{ cm}^{-3}$  at temperatures about 280 K and X2-traps in concentrations up to  $6 \times 10^{13} \text{ cm}^{-3}$  at temperatures about 390 K, their thermionic emission energy being about 0.5 eV and 0.77 eV respectively. While an X2-trap is an EL2-center presumably in the complex with an  $\text{As}_{\text{Ga}}$ -defect, an X1-trap or EL3-center is a seed defect in GaAs. The spectra of these n-GaAs layers after bombardment contained a higher peak associated with X1-traps, peaks associated with N1-traps and N2-traps, their thermionic emission energy being about 0.18 eV and 0.36 eV respectively, and also a wide band associated with N3-traps (average thermionic emission energy about 0.66 eV). After bombardment by a neutron flux of  $3 \times 10^{14} \text{ cm}^{-2}$ , at a temperature about 365 K the spectra included also a step associated with N4-traps near the E5 peak in the spectrum of GaAs after electron bombardment. A characteristic feature of the spectra of deep traps in n-GaAs after strong neutron bombardment was a wide U-band at temperatures within the 235-335 K range, an asymmetric band with a trailing edge below 235 K. This band, earlier thought to be either a combination of several peaks associated with various centers in the disordered region or a distortion of the band associated with radiative EL2-centers owing to their interaction with a shallower level, was later found to be most likely associated with preferentially isolated  $\text{As}_{\text{Ga}}$ -defects and with  $\text{As}_{\text{Ga}}\text{-V}_{\text{As}}$  complexes. Subsequent annealing of the layers was monitored by EPR-spectroscopy, which revealed at least three stages of their recovery and attendant U-band restructuring: 1) recombination of defects primarily in the crystalline host and vanishing of isolated E2, E3, E5, also possibly E4 defects at temperatures about 250°C and concurrent formation of secondary defects owing to the high initial concentration of radiative defects; 2) isolation of individual  $\text{As}_{\text{Ga}}$ -defects (not EL2-centers but rather DL2-centers) and their eventual preferential



"release" at temperatures about 450°C, as indicated by vanishing of the S-signal and recovery of electrical conductivity by the crystal lattice upon decay of secondary defect clusters; 3) removal of  $\text{As}_{\text{Ga}}$ -defects beginning at temperatures above 510°C with attendant attenuation of the U-band, as indicated by presence of the Q-signal.

The consistent shifting of the U-band to higher temperatures is evidently due to removal of point defects at preceding lower temperatures and possibly due to eventual formation of intricate defective clusters above 500°C during breakup of the disordered region and annealing of  $\text{As}_{\text{Ga}}$  defects. Figures 3; references 11.

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